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IMPROVED REVOLVING SODA ASH FURNACE.

THE revolving black ash furnace, or the "revolver," as it is generally termed in the chemical trade, furnishes another instance of how mechanical inventions are gradually being applied to every industry with the object of reducing the cost of production. This machine is used in the manufacture of soda, an industry, says *The Engineer*, that has developed within a comparatively short period into a trade of considerable magnitude. Some idea of its extent may be gathered from the fact that in 1883 no less a quantity than 708.070 tons of salt were converted into 602,250 tons of alkali, of which about 120,000 tons were caustic soda. Its enormous expansion in recent times is shown by comparing these figures with those of the year 1862, when only 254,600 tons of salt were used, and caustic soda was only a scientific curiosity, or at most a laboratory reagent.

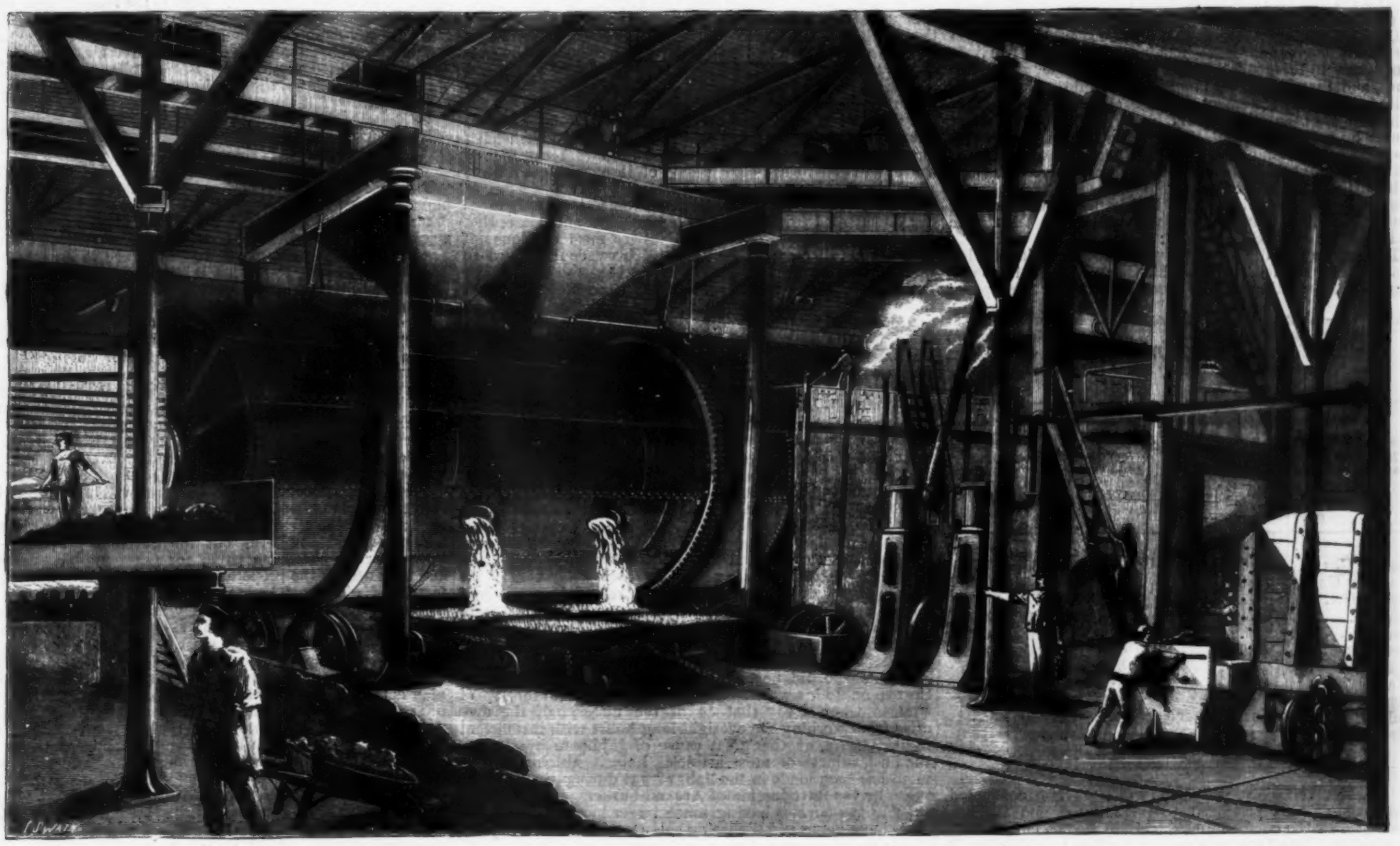
This rapid development has naturally called forth many improvements in the apparatus employed, and among the most important of these may be placed the revolving furnace. The process by which the great bulk of the alkali is produced is that known as the "Leblanc," so named after its illustrious originator, in which the chloride of sodium, or salt, is first converted into sulphate of sodium, and then, by fusion with carbonate of lime and slack, into black ash, or crude carbonate of soda, out of which the soda is first dissolved in water, and then recovered by evaporation. The process of fusion was originally done exclusively in hand furnaces, a practice which involved a great amount of heavy manual labor, in order to insure sufficiently intimate and uniform mixture of the materials, and to expose every part to the action of the heat. About the year 1852, Messrs. Elliot & Russell, of Wallsend, then of the Patent Alkali Company, St. Helens, perceiving the advantages to be gained by the substitution of some mechanical means of mixing the materials in the furnace for the old laborious method of hand rabbling, conceived the idea of making the furnace bed in the form of a horizontal cylinder which in its revolutions should mix up the charge by continually rolling it over upon itself. Like most inventions of any importance, however, the revolver has had an eventful career, and its ultimate success stands as another tribute to the perseverance and ability of our manufacturers.

The following short *resumé* of its history may prove interesting to some of our readers. Several experimental furnaces were originally made by Messrs. Robinson, Cooks & Co., of St. Helens, for Messrs. Elliot & Russell, but great difficulty was experienced in so mixing the charges as to make the soda in the product easily soluble. In 1854 a larger one was made, and sent to the Jarrow Chemical Company, South Shields, where it was worked for many years. It was here that the successful method of working the charges in the revolver was accomplished, and the credit of making the machine a practical success for the soda process belongs to Mr. J. C. Stevenson, M.P., the present representative of South Shields.

Many years elapsed, however, before the invention was taken up by the alkali manufacturers generally. Messrs. Gaskell, Deacon & Co., of Widnes, and Messrs. A. G. Kurtz & Co., of St. Helens, subsequently adopted it in the year 1868. Since that time the number in use has rapidly increased, and now no works of any importance in the manufacture of soda is without one or more. As might be expected, the size of the furnace has gradually increased, until in the case under notice we have a revolver capable of doing the work of eighteen hand furnaces, though occupying the space of only three. This furnace was made for and erected at the Widnes Alkali Company's Works at Widnes, by Robinson, Cooks & Co., of the Atlas Foundry, St. Helens. It is capable of producing from 80 to 90 tons of black ash per day, thus making a notable addition to the capacity of what is already the largest works of its kind in existence, its weekly produce reaching 600 tons of finished caustic soda, and 130 tons of bleaching powder.

This revolver, which is the largest that has ever been made, consists essentially of three parts—first, the heat generator seen on the left hand; secondly, the bed in the form of a large hollow revolving cylinder, which contains the materials to be operated upon, and through which the flames and heated gases pass; and thirdly, the gearing and engines seen at the right hand for driving the revolving cylinder round. The fireplace is rectangular, 17 ft. by 10 ft., with firing holes along one side; it burns 25 cwt. of coal per hour. The revolving cylinder is made of wrought iron plates, and is internally lined throughout with fire brick and encircled by two bearing or carrying rings, which run on four carrying wheels supported at a convenient height above the floor by strong box bed-plates. In the side of the cylinder are two openings provided with strong movable doors, which are secured to the shell by necessary bolts and straps. When it is required to charge the cylinder, the doors are taken off and the cylinder is turned round until these openings are directly under the charging hoppers seen overhead in the engraving, which have previously been filled with material from charging wagons running on an overhead railway, on to which they are lifted by a powerful steam hoist seen on the extreme right. As the revolver is represented in the engraving in the act of being discharged, no explanation is necessary except to mention that the bogies as they receive the finished charge are drawn along by a steam winch.

Movement is communicated to the revolver by means of strong spur gearing, and a pair of coupled steam engines, so arranged as to run at varying speeds to suit the operation in its different stages. Though this furnace is remarkable and important for its great size alone, it also possesses special interest from the fact that it is fitted with the patent solid cast steel combined bearing or carrying rings of Mr. Cook. These carrying or bearing rings have hitherto been made of cast iron, having wrought iron or steel tires shrunk upon them; but owing to the elongation of these tires from the continual rolling action when at work, as well as from the different ratios of expansion between the iron and steel, these tires frequently come loose and become troublesome. By this improvement in the construction by Mr. Cook, the tires are dispensed with altogether, and the carrying rings themselves are made of solid cast steel, so that the fruitful source of trouble and loss in the loosening of the tires is entirely obviated. These revolving furnaces of a smaller diameter have also been made by Messrs. Robinson, Cooks & Co., for some of the large glass works in St. Helens, for use in one of the many processes of that important branch of trade.



IMPROVED REVOLVING SODA ASH FURNACE.

ARTIFICIAL LIGHTING.*

IN early times but a small fraction of our forefathers' lives was spent under artificial light. They rose with the sun and lay down to rest shortly after sunset. During the long winter evenings they sat around the fire, telling stories and singing songs of love and war; the fire-light was sufficient for them, except occasionally during grand feasts and carousals, when their halls were lighted by pine-wood torches or blazing cressets. But, as a rule, after sunset they lived in semi-darkness.

From that early period, as man has advanced in civilization, in the thirst for knowledge derived from books, and in following the gentler pursuits which demand an indoor life, there has been a steady increase in that fraction of our lives which is spent under light other than that of the sun. But the improvement in the quality of the artificial light has been very slow. The ruddy lights and picturesque shadows so faithfully handed on to us by Rembrandt's pictures show us very graphically what our poets have called "the dim glimmer of the taper" of those days. A few years before the introduction of gas, Argand, by his improvements in the burners of oil lamps, enabled our fathers to see for the first time a comparatively white light, but as far as the matter we to-day propose to discuss is concerned, viz., the effect of artificial lighting, and more particularly electric lighting, on our health, we need only consider the reign of artificial light as it commenced with the general use of gas and petroleum, for then and only then could it be said to affect our health.

Prior to the introduction of the electric light we have been accustomed to consider every hour spent under artificial light as an hour during which all conditions are less favorable to perfect health than they would be during daylight. Can we now hope to ameliorate this condition of things through the agency of electricity? Before we can discuss this question I must point out to you the chief differences which exist between hours of work or recreation spent in daylight and un-

* Lecture delivered at the Health Exhibition by Mr. R. E. B. Crompton.

der artificial light. In the former case we live in abundance of light. The sunlight itself exercises a subtle influence on our bodies; that mixture of heating and chemical rays which when analyzed form the solar spectrum, and combined form the pure white light of daylight, is needed to enable all animal and vegetable organisms to flourish in the fullest conditions of healthful life.

In nearly all cases, when the sun is up, the functions of life are in the state of fullest activity, and when it sets they sink into comparative repose. In daylight life wakes, in darkness life sleeps. In addition to the abundance of pure white light, the heat attending is only that necessary for health. The air remains unvitiated, except by our own breathing. On the other hand, when working under artificial light, we have these conditions all altered in degree:

1. We have an insufficient light; a scale of lighting by gas or by electricity which would be pronounced excessive at night-time is still far inferior to average daylight.

2. All artificial lights, whether produced by combustion, as in the case of candles, oil, gas, and petroleum, or by the incandescence of a conductor by the means of electricity, produce heat; this heat, in proportion with the light afforded, is enormously in excess of the heat given by sunlight. Electricity, as you will see hereafter, is far the best in this respect, but even it is inferior to sunlight.

3. All these same illuminants, excepting electricity, contaminate the air and load it with carbonic acid, sulphur, and other compounds—all injurious to the health and to the general comfort of the body. It will be convenient to consider the effects, first, on our health generally; second, on our eyesight in particular.

I have already called your attention to the fact that that proportion of colored rays which, when combined, form white sunlight, is that best suited to healthy life. It is necessary, too, to that sufficient and proper stimulus to the organic changes which go on in our bodies, and which we call a state of good health. The various artificial lights differ very widely from sunlight in this respect—that they are all more or less deficient in the rays at the violet end of the spectrum, commonly called the actinic rays, and which most probably exercise a very powerful effect on the system. It is the want of a due portion of these violet rays which makes all artificial light so yellow. Even the light of the electric arc, which is richer in these rays than any other, is still on the yellow side of sunlight. The incandescent electric light is next best in this respect; next in order come gas, petroleum, and the various oil lamps. No doubt some of you will challenge my statement that the electric arc is yellow. It has always been called a cold blue light. It is not so; it is only by comparison with the yellower light of gas or with the incandescent lamps that it appears blue; when compared with the sunlight reflected from a white cloud, it will be seen to be distinctly yellow in tinge; but still both classes of electric light are far superior to all others in nearest approaching the white light of daylight, and thus satisfying the actinic action which our bodies demand.

Turning now to the comparative heating and air-vitiating properties of artificial lights, which we shall find it convenient to take together, I have here a table (Table A) prepared

TABLE A.—*Showing the Oxygen consumed, the Carbonic Acid produced, and the Air vitiated, by the Combustion of certain Bodies burnt so as to give the Light of 12 Standard Sperm Candles, each Candle burning at the rate of 120 grains per hour.*

Burnt to give light of 12 candles, equal to 120 grains per hour.	Cubic feet of oxygen consumed	Cubic feet of air consumed	Cubic feet of carbonic acid produced.	Cubic feet of air vitiated.	Heat produced in lb. of water raised 10° F.
Cannel Gas....	3·30	16·50	2·01	217·50	195·0
Common Gas...	5·45	17·25	3·21	348·25	278·6
Sperm Oil.....	4·75	23·75	3·33	356·75	233·5
Benzole........	4·46	22·30	3·54	376·30	232·6
Paraffin........	6·81	34·05	4·50	484·05	361·9
Camphene......	6·65	33·25	4·77	510·25	325·1
Sperm Candles.	7·57	37·85	5·77	614·85	351·7
Wax " .	8·41	42·05	5·90	632·25	383·1
Stearic " .	8·82	44·10	6·25	669·10	374·7
Tallow " .	12·00	60·00	8·73	933·00	505·4
Electric Light..	none	none	none	none	13·8

by Dr. Meymott Tidy, which shows the oxygen consumed, the carbonic acid produced, the air vitiated, and the heat produced by the combustion of certain bodies burned so as to give the light of twelve standard candles, to which Mr. R. Hammond has added the heat produced by a 12-candle incandescent electric lamp. From these figures you will see that the air of a room lighted by gas is heated twenty times as much as if it were lighted to an equal extent by incandescent electric lamps. When arc lamps are used, the comparison is still more in favor of electricity. You will be surprised to see from the table that our old friend the tallow candle, and even the wax candle, is far worse than gas in the proportion of air vitiated and heat produced, and you will be disposed to disbelieve it; but the fact is, that so long as candles were used light was so expensive that we were obliged to be content with little of it; in fact we lived in a state of semi-darkness, and in this way we evaded the trouble. It is only since the general introduction of gas and petroleum that we have found what an evil it is.

It is not unusual, in fact it is almost invariable, for us to find the upper stratum of air of the rooms in which we live heated to 120° after the gas has been lighted for a few hours. We have grown accustomed to this state of things, and are not surprised that when we take the library ladder to get a book from the upper shelf we find our head and shoulders plunged into a temperature like that of a furnace, producing giddiness and general malaise. If you look again at the table, you will see that each gas burner that we use consumes more oxygen and gives off more carbonic acid, and otherwise unfits more air for breathing, than one human being, and it is this excessive heating and air vitiation combined which are the main causes of the injury to the health from working long hours in artificial light.

I could go on for a long time giving instances of the fearful state of the atmosphere of our large public buildings as well as of our private homes after the gas has been lighted for a few hours, but this paper is not considered as an onslaught on gas; moreover, these ills are so well known to nearly all of you that I need not bring them more prominently before you. I will only take one instance, viz., that of the Birmingham Town Hall, which has been lighted alternately by gas and electricity.

During the grand Birmingham Musical Festival, which was held in that hall two years ago, some careful experiments were made to show how the orchestra and audience in the hall were affected by the two kinds of lighting. The gas lighting was in the form of several huge pendants suspended from the center of the hall. The electric lighting was in the form of clusters of lights placed on large brackets projecting from the side-walls with two central pendants placed between the gas pendants. The candle-power given by the electric light was about 50 per cent. in excess of that given by the gas light; the degree of illumination by electricity was consequently very brilliant.

It was found that when the gas was used the temperature near the ceiling rose from 60° to 100° after three hours' lighting. The heating effect of the gas was, therefore, the same as if 4,230 persons had been added to the full audience and orchestra of 3,100. Similarly the vitiation of the air by carbonic acid was equal to that given off by the breathing of 3,600 additional persons added to the above audience of 3,100. But on evenings when the electric light was used, the temperature only rose 1½° during a seven hours' trial, and the air, of course, was only vitiated by the breathing of the audience. The further experiment was tried of giving to every member composing the large orchestra a printed paper of questions, asking how the new mode of lighting affected him or her personally, and I have here 265 replies to those questions. They are very interesting. I will read a very few of them out to you. From this you will learn that without exception the comfort and general well-being of the large orchestra was increased enormously by the use of this new illuminant, yet it is reasonable to suppose that the comfort of the audience was increased in an equal degree. Now we all of us know that the times when we suffer most from the effect of artificial light is in crowded places of public amusement, which are at the same time brilliantly lighted. Many of us are unable to go to the theater or to attend evening performances of any kind, as the intense headache which invariably attends through staying a single hour in such places entirely prevents them. This headache we commonly say is inseparable from the heat and glare of the gas. Now this phrase is not strictly correct. It is no doubt due to the heat of the gas and its air-vitiating properties, but when we use the word glare I believe we refer to the effect the gas-light has upon our heads, and which effect is not due to excess of light. On the contrary, I believe if a far greater amount of light be given by the electric light without the heating and air vitiation being present, such headache is never produced, although some of the more tender-headed among us will at first complain of the glare because they are habituated to associate plenty of light with great heat, great air vitiation, and other evils.

Indeed, so long have we been accustomed to closely associate brilliant artificial light with headache and glare, that we who are introducing electric light are most cautious not to give the full quantity of light which we could afford to give, and which would afford the greatest rest to the eye and greatest bodily comfort. I now come to the effect that light has upon the temperament. If we try the experiment in an assemblage of people of gently decreasing the lighting of the room, it will be found that the spirits of every one will be depressed just as the light is depressed, and, *vice-versa*, their spirits will be raised just as the light is raised. I have many times, when conducting experiments of electric lighting on a large scale, noticed this fact, and I have been led to the conclusion *that during hours of waking every person is benefited by increase of light up to the extent of full sunlight*, provided that this high degree of lighting is not attended by heat and by air vitiation; and I must add that the source of light must not be from one or two brilliant points only, but it must be well regulated and not such as to cause dark, deep shadows.

This leads me on to the subject of the effects on the eyesight of the electric light as compared with other lights. *Healthy eyesight demands a plentiful supply of light. It is the greatest mistake to suppose that a state of semi-darkness is good* for our eyes, unless they are defective, or recovering from the effects of past injury or disease. Whoever saw a painter, engraver, printer, watchmaker, or indeed any one the quality of whose work depends on the excellence of his eyesight, who did not desire a flood of pure white light thrown on to his work? I think I have the authority of oculists when I say that ½ of the diseases of the eyes arise from working the eyesight long hours with insufficient light. Again, another great cause of injury to eyesight is the unsteadiness of most artificial lights. Much improvement has been made in the light of gas during the last few years by the introduction of Argand burners, and globes for the flat gas burners having much larger lower openings, so that the dancing and flickering batswing burner of five years ago is not so common in a good house.

Even the steadiest of the modern gas burners is extremely unsteady as compared with the light of the incandescent electric lamp. Those of you who have been to the Savoy Theater will have noticed the effects of the lights behind the scenes on the scenery itself. The light is so absolutely steady that it is comparable to sunlight. Hitherto I have said nothing as to the comparative excellence of the two forms of electric light, viz., the electric arc and the incandescent lamp. Both have their proper places. The arc light, which is the whitest in color and most economical to produce, is not so steady as the incandescent lamp. It is therefore unsuitable for indoor use or for reading by, or for such occupations as require the maximum of steadiness. But it is well suited for the lighting of large buildings and public places.

I am unaware if any experiments have been made as to the effects of brilliant arc lighting on the eyesight of men who have to work night shifts, as although the opinion of the workmen who have to work under it is unanimous in its favor, yet that opinion is more based on their personal comfort, due to their being able to carry on their work with facility almost equal to that given by daylight. The large sorting rooms at the General Post Office at Glasgow have been for a long time lighted by the arc light, and with a most beneficial result to the health and eyesight of the letter sorters and telegraph clerks. The former occupation is one which tries the eyesight very severely. The public generally does not know how the habit of writing the addresses on envelopes with pale ink and blotting it off rapidly before it has time to darken tries the eyesight of the Post Office letter sorters.

So long as gas is used, a powerful burner has to be brought very close to the head of the sorter, and under such conditions the eyesight fails at an early age. At Glasgow Post Office I am able to boast that by the introduction of the electric light I enabled many of the more aged sorters who were commencing to use spectacles to do without them—and even I put back the clock of time in enabling several who had used them for some years to disclaim them. I am aware that it has been alleged by the opponents of the electric light, whether interested or otherwise, that in many cases the intensity of the light has injured eyesight. I do not think any such cases can be substantiated. Many of us who are in the habit of experimenting with powerful arc lamps have had our eyelids temporarily affected by incautious exposure at too short a distance. Again, over and over I meet with the complaint that if I stare at an arc lamp for a long time it will make my eyes ache; the obvious retort being, Why should you stare at the light? If you do the same with the sun, you will be equally inconvenienced.

Before such an audience as this, which is of course familiar with the beautiful electric lighting in the Health Exhibition itself, it is useless for me to enlarge on the many conditions of the electric light as it indirectly affects health. I may only name the many additional pleasures of the eye we get from its use. Our flowers in our rooms do not fade away, and are seen in their true colors. Our pictures or all colored objects are seen to better advantage. I may mention one thing which would not generally occur to you, that in London certainly an electric lighted house can be cleaned properly in winter. You may smile at this, but I assure you that the advantage of being able to turn a flood of light into your drawing rooms and dining rooms at six o'clock on a winter's morning, so that the whole of the cleaning can be finished as thoroughly as if done by day light, before the family comes down to breakfast, is one that must be experienced before it can be thoroughly appreciated. Again, the advantage to the health of our children is simply inestimable.

No night-lights, matches left about, or gas turned down low is required. A child six years old can be trusted to press a button and so turn the light off or on; the lamps being high and out of reach are not easily broken or overturned, and the air of the children's nursery, even if the light be kept burning the night through, remains pure throughout. Another indirect advantage due to the absence of heat is that it is comparatively easy to thoroughly ventilate and cool during the hot weather a room lighted by the electric light. The heat of gas placed high in the room causes such intense draughts when the windows are open that the discomforts and dangers of the draughts are almost worse than the discomfiture from the heat and vitiated air, whereas in an electric lighted room there is no difficulty in opening wide all the windows, the draughts produced being so gentle as to be hardly felt.

HOW TO ALBUMENIZE PAPER.

THE first thing is to decide how much albumen has to be prepared to coat the quantity of paper required. As a guide, it may be mentioned that a ream of paper will consume from a gallon and a half to two gallons of albumen; and as one egg yields from three-quarters of an ounce to an ounce of albumen, according to its size, it is easy to arrive at the number that will be required to coat a given quantity of paper, bearing in mind that more than is actually consumed by the paper must be prepared—sufficient to well cover the bottom of the dish when the last sheet is floated. Thus, a couple of quires of paper (a convenient quantity for an amateur to prepare at a time) will take something like a quart of albumen; this, on an average, will be obtained from about fifty eggs. If the paper be coated in the whole sheet, of course considerable more than this will be necessary; but for the nonce we shall assume that the paper will be prepared in quarter sheets, as that will be the most convenient size for the novice to commence with.

Fresh white of eggs can now be purchased in any quantity, the egg merchants finding it to their advantage to break the eggs and sell the albumen and yolks separately, as there is a large demand for both, but for different purposes—the former for albumenizing paper for photographic purposes, and the latter in the preparation of kid leather for the manufacture of gloves. Therefore, when the albumen can be conveniently purchased separately it will be found more economical. However, we shall assume that this cannot be done, and therefore the eggs must be broken by the operator himself. Here some little dexterity is required in order to avoid the yolk getting mixed with the whites. The best plan is to break the egg by giving it a smart tap on the edge of the cup, and then drain the albumen into it, retaining the yolk in the shell. By draining the white from each egg first into a cup, the yolk, if it be accidentally broken, does not get mixed with the bulk of the albumen. The yolks can, of course, be transferred to the culinary department, where they will doubtless prove acceptable.

It is generally recommended, in breaking the eggs, to separate the germ from the albumen, but this is never done in actual practice. With regard to the kind of eggs to be used, good ordinary French eggs will answer quite well, and they will be found practically as good as the more expensive "new laid." The requisite quantity of albumen being obtained it is well stirred up, and to each quart three hundred grains of chloride of ammonium, dissolved in the smallest possible quantity of water, is added. The whole must now be converted into a perfect froth. Unless this part of the operation be very perfectly performed it will be quite impossible to insure a perfect coating. Professional albumenizers usually employ an American churn for this purpose; but, on a small scale, the domestic egg whisk borrowed from the kitchen will answer quite as well. The whisking must be continued until the vessel containing the albumen can be inverted for a minute or two without any of the albumen draining out. The vessel is then placed away in the cool place for three or four days according to the temperature, to allow the albumen to subside. By this time it will have become very limpid. If the albumen be kept in a cool place, and the eggs be tolerably fresh when broken, it will keep the above length of time without fear of decomposition. It could be used after a day's keeping, but it would be next to impossible to obtain a coating perfectly free from streakiness.

Some albumenizers, we believe, keep the albumen for a much longer period than that named—or until it has become quite putrid—before use, as then it is more easy to manipulate, and produces a finer gloss. We have been given to understand that dried blood albumen is sometimes added to thicken that obtained from the eggs, so as to obtain a still higher surface. However, the employment of decomposed and blood albumen was spoken of last week, and it need not be further alluded to here, the object of the present article being—assuming the paper such as that supplied some dozen years or so ago cannot now be purchased—to show how any one may prepare it for himself. The proportion of chloride recommended above will give seven grains and a half to the ounce of albumen, and will, therefore, be suitable

for a sixty-grain sensitizing bath similar to the one in vogue about that time.

Leaving the subject of the albumen for a few minutes, it will be well to direct attention to the paper itself. It is tolerably well known that the two sides of a sheet of paper are different, one being very smooth, while the other possesses a certain amount of roughness, due to the web upon which it was dried in its manufacture. Of course it is the smoother side which is to be albumenized. As the reams are received from the mill, the smoother side is always packed in the same direction; but when the ream is broken, and the paper sold in small quantities, it frequently gets mixed. Therefore it is necessary to examine each sheet separately, and in cutting it up—supposing it is to be prepared in less than whole sheet—to take the precaution that the smoother surface is arranged all one way, so that no mistake need be made in floating the wrong side on the albumen.

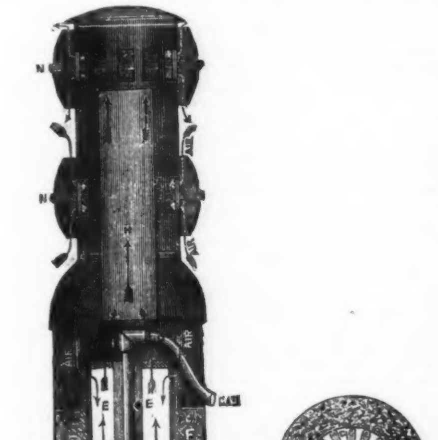
The albumen having stood the requisite time, it is now carefully strained; a fine cambric handkerchief will form a good medium for the purpose. After straining, the most careful albumenizers filter the albumen through a sponge; but this is scarcely necessary if the cambric be close in texture, and the albumen has been carefully decanted without disturbing the sediment. It is now poured into a dish of a suitable size, avoiding the formation of air-bubbles as much as possible. After standing for a short time, to allow any minute ones that may be accidentally formed to come to the top, the albumen is carefully skimmed by drawing a piece of blotting-paper along its surface. It is now ready to receive the paper.

In floating the paper some little dexterity is required to avoid bubbles, and many operators have different plans of placing it upon the albumen. Some bend the paper in a curve and apply the middle first, and then gently lower the two ends. Others, holding it by opposite corners (diagonally), bend it, and apply first one of the free corners, gently lowering it to the other, and finally lower the two corners by which it is held. Many apply the paper in this way, and it is the plan we prefer: Holding the sheet by its two ends, they place one on the surface of the albumen at one end of the dish, and gently lower the remainder. By this method any air-bubles, should they be accidentally formed, will be driven toward the end of the sheet, where they can easily be forced out by gently tapping the back of the paper with the tips of the fingers; whereas if any be formed when the middle of the sheet is applied first they are not so easily noticed, or expelled when they are.

When the paper is first applied—particularly if it be very dry—it will probably curl up and leave the albumen at the edges, but it will speedily flatten out again. It must not, however, be removed until it lies uniformly flat; otherwise the coating will prove unequal in thickness when dry. In practice it is advantageous to employ two dishes, and it will then be found that by the time the second sheet is floated the first one will have become flat and ready for removal, and thus time will be considerably economized. If the paper be floated for too long a time the albumen will sink deeply into it, and thus to some extent prevent a high gloss being obtained.—*Brit. Journ. of Photo.*

SCHULKE'S RECUPERATIVE GAS LAMP.

THE accompanying illustration shows the design of the regenerative gas lamp invented by M. Schulke, and exhibit



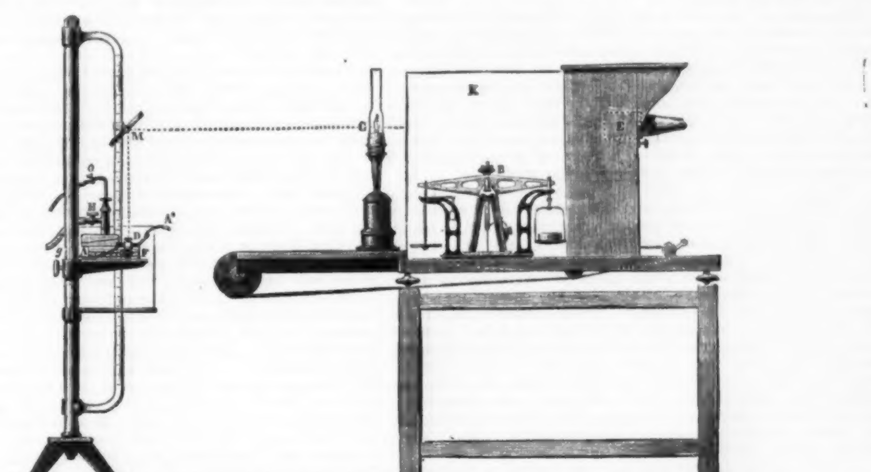
IMPROVED RECUPERATIVE GAS LAMP.

ed at the last meeting of the *Société Technique de l'Industrie du Gaz en France* by M. Servier. According to the statements of the inventor, corroborated in respect of the example shown by M. Servier, this lamp is extraordinarily successful in economizing gas and producing a brilliant light. The performance of the burner is said to be equal to 9 6 carcels for a consumption of 300 liters per hour; being at the rate of 31 liters per carcel (about 9 candles per cubic foot). The smallest size of the Schulke lamps gives 34-candle power; and the largest yields 1425-candle power. These results are ascribed to the considerable heating surface of the lamp. As the mass of recuperating substance is relatively small, the lamp develops its intensity very rapidly. The flame is steady and brilliant. An important point yet unsettled by experience in the working of the lamp, as pointed out by M. Servier, is the durability of the recuperator, which is constructed of platinized sheet iron. On the other hand, the burner being composed of ordinary tips—fishtails or batswings—it follows that if the closed glass at the bottom is broken, the only inconvenience that could result therefrom would be the absence of regeneration, since the burners would continue to act in the ordinary way. The illustrations show a longitudinal and a transverse section. The new and especially interesting portion of the arrangement is the regenerator. It is made of platinized sheet iron, folded longitudinally in the manner shown, so as to present a star-like cross section. This tube, E, is placed in the middle of a circular casing, F, made of a substance that does not readily conduct heat. The air passes by the channels, G, in the course indicated by the arrows, by the draught of the chimney, H; while the combustion products rise through the interior channels, K, which are thus made red hot. The spent gases join in L, to escape by the chimney, H. The air enters by the holes, M, protected from draughts by the crown, N; while the outlets, O, are similarly protected. The gas enters by the pipe, P, and supplies the cluster of burners, Q, the flames from which do not touch. The glass, R, closes the bottom of the lamp; and the pilot light, S, prevents the necessity for opening the lamp. In many regenerative systems the lighting up presents the difficulty that before a regular draught is set up the products of combustion may be cooled sufficiently to fall down and extinguish the flame. In M. Schulke's lamp this inconvenience is avoided by the use of the central chimney, T, which is enlarged at the base into a combustion chamber, V.

ANOTHER FORM OF THE PLATINUM UNIT.

WHEN recently describing the new platinum unit of light, as devised by M. Violle, we mentioned that certain experiments with the standard had been carried out at the central testing station for Paris gas, with the assistance of M. Leblanc. Through the kindness of M. Violle, we are now enabled to present the accompanying illustration of the arrangement devised for this purpose. The object of the experiment was the determination of the equivalent of the Carcel lamp.

In the present figure, which represents the usual apparatus constructed by M. Deleuil for testing the Paris gas by reference to a standard Carcel lamp, C is the lamp, standing on a traveler by which it may be moved from or toward the screen contained in the box, E. The paths of the rays from the two sources are separated by the dividing screen, K. This, with the balance, B, for weighing the lamp (which must burn at the rate of 42 grammes of colza oil per hour), constitutes the established portion of the Foucault photometer; the new standard and its fittings being separate as shown. Here we have the crucible, F, with its cover half slid back to expose the surface of the bath of molten metal through the hole in the diaphragm, D. This diaphragm (of thin platinum, and hollow) is kept cool by the constant current of water flowing through A', A. The oxyhydrogen blowpipe for melting the platinum through the cover of the crucible is shown at O and H. A thin black line is marked, starting from the lower sliding bracket of the tripod, *g*, which indicates the blackened box surrounding the crucible in order to cut off disturbing radiations from any of the heated surfaces. The legitimate rays of the standard first pass vertically upward to the angle mirror, M, which reflects them (on the same level as the rays from the Carcel lamp) to the screen, E. The lineal distance from the surface of the standard to that of the mirror is shown by the graduated vertical scale attached to the tripod, which in turn is placed at a measured distance from the screen, E.



The experiments with this apparatus were conducted by three observers. M. Leblanc supervised the tests; the manipulation of the lamp and the readings of the screen were made by M. Coupaye, one of the Municipal Gas Examiners; while M. Violle was occupied in looking after his molten platinum. In a general way one of these three observers might perhaps be dispensed with; but two, as testified by M. Leblanc, would always be necessary—one to look after the readings and take care of the photometer proper, while the other would be wholly engaged in observing the condition of the platinum. The actual record of the experiments is as follows, taking S as the useful surface of the platinum (*e. g.*, the area of the diaphragm opening); D being the distance from this surface to the photometer; *d* the distance from the lamp to the photometer; *p* the weight of oil burnt by the lamp in one hour; and *r* the coefficient of reflection of the mirror. In the first of the series of tests, S = 3·68 square centimeters; D = 3·218 meters; *d* = 1·278 meters (being the mean of three separate observations); and *p* = 43 grammes; $\frac{1}{r} = 1{\cdot}204$. Whence C, or one standard carcel, $= \frac{1}{2{\cdot}078}$. In the second series of readings, S = 3·96 square centimeters; D = 3·204 meters; *d* = 1·246 meters (being the mean of five distinct observations); *p* = 43·4 grammes; $\frac{1}{r} = 1{\cdot}204$. Whence $C = \frac{1}{2{\cdot}077}$, which is (within a fraction) the mean of both series. The actual reflection from 3·96 square centimeters of the surface of the molten platinum is, therefore, from these observations, equal to the light of 6·882 carcels; or, taking the carcel at 8·91 English standard candles (as stated by M. Violle), to 61·32 of the latter—truly a brilliant standard to work with. It is, as already stated, almost exactly eleven times the brilliancy of the Carcel lamp flame, for equal areas.—*Jour. of Gas Lighting.*

[Continued from SUPPLEMENT No. 453, page 7235.]

ON ELECTRICITY AND ITS PRESENT APPLICATIONS.*

By W. FRASER, A.M., M.R.C.S. Eng.

As none of the necessary elements of life are so indispensable as Electron, so there are none of them so universally diffused, accessible, and in fact inseparable from all living things. These can be very easily, and often with fatal results are, deprived of heat, light, air, or water, and food; but no prison or solid walls, no laws or ingenuity of man, can deprive them of the presence and ministrations of this all-pervading spirit. The toad or frog shut up for hundreds of years in a solid rock can be kept alive by this, the only *pabulum vitæ* which can have access to it.

The invaluable services of Electron, too, for specific purposes are also at the constant command and use of all mankind. The breast of mother earth can be tapped, so to speak, anywhere and at any time, and the necessary supply of energy drawn from it, provided the individual has the requisite knowledge and skill to use the appropriate means for the purpose. These means, in the present state of our knowledge, are, it must be admitted, somewhat complicated and expensive, and sometimes not even devoid of danger; but in the progressive advancement of science and experience there is no doubt the means will yet be discovered by which his services, whenever and wherever they are wanted, will ultimately be much more readily and simply brought within the reach of mankind.

When Electron is made closely to embrace and to pass repeatedly around a portion of his favorite metal, it becomes magnetic—that is to say, so imbued with his spirit as to have the power of attracting to itself, and holding firmly, portions of the same metal equal or even greater in weight than itself. This fact or phenomenon forms the basis of what may be called the science of electro-magnetism, and is the source of the motive (electromotive) power which is the great agent in many of the achievements of Electron. A variety, too, of the metal iron, called loadstone, is to be found in some parts of the world which has the same quality with the addition of being able, by close contact and repeated embraces, to communicate it permanently to other members of the ferric family. And in connection with these an important passage in the history of Electron has now to be mentioned.

These magnets, as they are called, have a tendency to arrange themselves, and when allowed perfect freedom of motion do arrange themselves, in a line parallel, or nearly parallel to the axis of the earth—a wonderful property, which is taken advantage of (and has been for many centuries) in the form of the mariner's compass, for the safe guidance of ships across the pathless ocean. But less than one century ago a Danish *savant*, named Oersted, discovered another singular peculiarity of these magnetic imps, namely, that the instant they find themselves in the presence of Electron they make a reverential sign of obeisance to him, which he (doubtless in some way to us invisible) acknowledges. If he approach them in front, they turn to him by a movement of the right; if he approach them from behind, they face around to him by the left; always retaining their position across, or at right angles to, his path, during the presence of their great chief.

Little did Oersted foresee the important uses afterward to be made of the little odd peculiarity he had discovered; but succeeding wise men who have given themselves to the service of Electron, by taking advantage of this devoted attachment to their chief of these small magnets, have devised a way by which persons living at the greatest distance from each other may hold almost immediate correspondence. And this is the way in which this godlike achievement can be accomplished: A copper or iron wire is laid either above or below the ground, or along the bottom of the sea, of any length, from a few yards to thousands of miles, and the genie being exorcised, *secundum artem*, from his place of concealment, can be sent by qualified attendants or operators along this favorite pathway to the place intended, where it is made to pass across one or more of the magnetic imps, who instantly give him the *quasi* military salute just described. These transmissions and salaams can be repeated so rapidly and timed and grouped together in such a way, that a code of signals can be formed by them that shall be equivalent to ordinary language, and be easily transferred into it by those in charge at either end of the wire of communication; and so rapidly can he do his work that three or four clerks, at either end, can be sending and receiving messages, and nearly as quickly as they could be spoken. At the same time, by the same wire, Electron can even write out the intelligence he conveys as fast as it is sent, provided he is supplied with the necessary materials and suitable apparatus for the purpose.

But what is still more wonderful, and demonstrative of the power and wisdom of the Master whom he serves, this genie can in an instant send his voice, in an audible and intelligible form, to a distance of hundreds, or even thousands, of miles. And this is the way in which this lately discovered

* Read at the Aberdeen Philosophical Society, February, 5, 1884.

power of his can be applied to the service of mankind. An imp belonging to the ferric or some of the other tribes for which Electron has a partiality is selected, of a thin, expanded, delicate, and highly sensitive structure, and is placed in a position where the genie can have free access and contact with it. A person wishing to speak with another at a distance (whether a few streets or a thousand miles away) has only to address his words near to this imp, whose sensitive body is immediately made to vibrate in harmony with the sound waves of the voice. These delicate and invisible vibrations are recognized and received by the genie where he lies enveloping the atoms of the imp, and are by him carried to the other end of the line of transit, where they are repeated by him in the body of another imp similarly placed in regard to the conducting medium, with the result of causing corresponding vibrations in the air, so as to reproduce sounds and words exactly corresponding to those emitted by the speaker at the distant station, so that his listening friend can hear them instantly and exactly as they were pronounced, so exactly indeed (as probably many of you have had an opportunity of verifying) that the person listening can say at once, "This is Mr. So-and-so," or that is an Englishman, an Irishman, a Frenchman, or a lady, or a child.

Intelligence so transmitted by either of these methods can be quickly communicated by messenger to the person for whom it is intended, or to the public by means of the newspaper and the post; and so the spirit Electron may be said to supply the office of a nervous system to the world, keeping all its parts in immediate sympathy with each other, and enabling them to act in harmony for the general advantage. And thus, by the immediate and unimpeded interchange of intelligence, and the prompt removal of prejudices and misunderstandings throughout the world, Electron is becoming one of the chief harbingers of the "good time coming," that millennium which many of the nations are longing for and looking forward to.

The delicate perceptions and touch of women are found to be peculiarly adapted for these manipulations, and it must be gratifying to the advocates of women's rights to find that a new field has thus been opened up for their employment which is at one congenial, scientific, and remunerative. In one room alone at the London Post-Office, in St. Martin's-le-Grand, there are a thousand female clerks, whose active brains and fingers are constantly at work; and from this instance we may judge of the vast army of women employed in the service of Electron throughout the world!

The movements of a spirit such as Electron are essentially of a different nature from those of material things which are acted upon by the laws of gravitation and other forces which are readily recognized by our senses, and which can be intelligibly comprehended, measured, and practically formulated. Spirits like Electron, being almost destitute of weight, cannot, unless in a slight and indirect way, be influenced by gravitation. Their inconceivably rapid motion is entirely unlike that of gravitation, being more of the nature of mental emotion or of vibration than of a bodily change of place. The electric spirit, in so far as it enters into the constitution of material things, and functionally permeates and envelops them, will accompany the world in all its movements; but in other respects it will not accompany it, and will only but slightly participate either in its rotation or its orbital motion.

It will thus be understood that the earth, in its diurnal motion, brushes through and athwart the portion of this spirit that lies nearest to it at the rate of 17 miles per minute at the equator, and at a gradually diminishing rate toward the poles; or, it comes to the same thing to say that the genie traverses the surface of the earth at this rate along the parallels of latitude from west to east. One result of this is that the whole army of magnetic imps throughout the world that have, from their size and constitution, the requisite freedom of movement, must continually assume the rectangular or military position toward their great chief; in other words, they will point in the direction of the terrestrial poles, a permanent and invaluable phenomenon, which, utilized in the guise of the mariner's compass, constitutes one of the greatest blessings to mankind. As a curious presumptive corroboration of this idea, a well known experiment may be called to remembrance. If a rod of soft iron be suspended at right angles to the electric or magnetic current, that is to say, nearly north and south, with a considerable dip to the north, and smartly and repeatedly struck, so as to put its particles in a state of vibration, these particles, or a certain portion of them, will assume the deferential or military attitude, and retain it *permanently*, along with the magnetic power which it confers, thus converting the rod into a magnet.

This powerful genie does not disdain to act the part of a most useful and obedient servant or slave to mankind. Without his spontaneous assistance, as the fermentative agent, the processes of baking and brewing could not be successfully carried on. In the nutrition and growth of plants he acts a very important part, and, as the late Sir Charles Siemens has experimentally proved, can be used artificially to expedite and improve their fruit producing powers to an extraordinary extent. He can, by a little skillful management, be made to work sewing and other domestic machines; to ring bells of warning at any distance that may be required; to transmit messages to any distance with accuracy, and with a promptitude that no human messenger could equal; to act the part of a watchman, and give instant warning of the approach of burglars or thieves. He can send warning to a distance of the escape, and anticipate the movements, of criminals, so as to lead to their apprehension, and thus prove a powerful aid to law and good government. He will even detect the outbreak of fire, and give timely warning of it. He transmits true time, and keeps our clocks in harmony with each other in all parts of the kingdom. He gilds and plates our spoons and metallic goods; he reproduces to any extent our medals and works of art, including the most valuable engraving plates. He can, at a safe distance, detonate the charges used in quarrying and mining, and can explode torpedoes and other explosive contrivances, whether used for warlike or peaceful purposes.

Dr. Bain suggests that he should be employed by schoolmasters for inflicting the various degrees of punishment required in public schools, and it has been proposed that he might with advantage be made to perform the office of public executioner, and by an instantaneous and certain death to do away with the hateful and sometimes bungling services of that functionary. He affords to scientists the means of collecting from and transmitting to all parts of the world invaluable and timely information and warning in regard to passing events, and notably to the state of the weather and the approach and the direction of storms, so as, in many cases, to give time and opportunity for the avoidance of the dangers arising from them.

There is a gentleman (Mr. Robert Davidson) still living in Aberdeen, and whom I have the pleasure of calling my friend, who, forty years ago, constructed an electromotive machine which was tried on the Edinburgh and Glasgow Railway, being the first attempt of the kind; but the speed attained was so far below that of the steam locomotive that the undertaking had to be abandoned, and it had no practical results at the time. And even yet, though there are one or two electric railways in operation on the Continent, there is no indication shown that the present arrangement will be superseded for many years to come.

These are only a few of the numberless benefits for which we are indebted to Electron. But there is one department of public and domestic importance where his services are available, and where they are destined—possibly at no distant date—to add another contribution to the welfare and happiness of the world; he can be made to assume the character of an angel of light, and to give forth, by self ignition, an unlimited amount of light, of a beauty and quality and freedom from noxious effluvia superior to any artificial light that can compete with it.

There are various ways in which the Magi and other operative assistants have been able to effect this transformation, but the usual and the most efficient is by making use of the intervention of another genie, whom scientists have much more completely under their command. This genie, though belonging to a lower order of beings, has within the last hundred years been proved to possess capacities—and has had them practically employed—for the promotion of the power, civilization, and enrichment of mankind, to an extent that is apt to mislead the ignorant into a belief that he is equal, if not superior, to Electron himself. He may be described as a hybrid, generated by the impregnation of water by Electron, and is invisible, like his father, but, like other beings of semi-terrestrial origin, is continually tending to return to the form and substance of his mother. He is the most extensively known and powerful of a large class of similar spirits, the result of the intrigues of Electron with nymphs of terrestrial lineage, and he derives his energy and strength from his father, and his pliancy and instability from his mother.

Vaporin, as he may be designated, can, by the connivance of men, be generated within strong iron closed vessels; and by the continual and powerful efforts which he makes to escape, and the strength he puts forth while making his escape, he can be made to do almost any kind of mechanical work through the intervention of connecting belts or chains, and of ingenious and appropriate machinery. Well, this Vaporin genie can be made to rouse the nobler spirit of his father into violent excitement by driving to and fro, across his path, a number of electro-magnets, at the rate of several hundred times in a minute, and thus compelling him, in accordance with a law which is binding upon him, continually to respond to the salaams that are made to him by these electro-magnets. And in the pathway to the magnets there can be placed small gaps or interruptions in the form of some material, such as carbon, which he can pass through only with difficulty. And so, at the points where he has to cross these obstructions, the struggle that ensues betwixt him and the atoms of the carbon is such as to send forth a flash of light that can be compared only to that of the sun itself. The light produced in this way, then, though it appears to be continuous, is in reality only a succession of rapid flashes, running, as it were, into one. In this magical transformation of electricity into light the part performed by Vaporin is merely that of a mechanical slave, and which could be performed almost as well by the force of gravitation, by wind or water power, or by muscular strength.

Though it has suited the drift of this paper to view Electron as a spirit specially belonging to the earth, where we can most readily perceive and understand his agency, there can be no doubt that he extends throughout and fills the universe itself or at all events that he is coextensive and homogeneous with light itself, which we know reaches us from the most inconceivable depths of space. And if we can only speculate in regard to most of his operations here, how little can we know, or even conceive, of the entire purposes for which he is employed by the Almighty Architect?

If we can imagine any part of space to be devoid of matter, *there* Electron would exist in his pure and primitive condition as a pure spirit. But with his power of motion (at the rate of 576,000 miles per minute), wherever he comes in contact with the innumerable accretions of matter, whether great or small, so profusely scattered through space, he would become imbued with some minute portion of it; and this, of course, is the form in which we have our experience of him. In some conditions of matter, as in the sun, for instance, through means of the commotions and rearrangements in it which are continually taking place, and in which *he* no doubt plays an important part, he would become imbued with a still larger—though yet inconceivably small—portion of it. And when reflected back from the sun, and now assuming the form of light, his motion would be retarded to one-third, or 192,000 miles per minute. The matter or material undulation thus diffused through space reaches our own planet, its motion being still further retarded by our atmosphere, in a form too attenuated to be identified by the most delicate chemical tests, though recognizable by the spectroscope. Yet, minute as it is, I believe it is continually contributing to the growth, and the health, and the beauty of all living things, as well as producing important changes in the inorganic world.

An ingenious—and it may be said mysterious—instrument, the radiometer, invented by Mr. W. Crookes, F.R.S., seems to afford confirmation of the idea of the material character of light. It consists of four thin square aluminum plates, weighing about 2 grains, attached to and projecting at right angles from a slender shaft of the same metal, and kept in position within a glass vessel from which the air is exhausted. The plates are bright on one side and blackened on the other. When exposed to light or to heat the shaft moves with a constant rotary motion, the most probable cause of which seems to be the impetus given by the undulations of light or heat impinging upon the bright sides of the metallic disks, while their dark sides attract and absorb its material (?) constituents, and are thus drawn toward it, so that the bright and the dark sides, thus differently acted on by the light, co-operate together in producing the constant rotation. The friction or resistance of the atmosphere being removed, and the pivots on which the axis moves being very fine, the slightest possible force is sufficient to cause the motion. When we see the tremendous force exerted by so rare and delicate a substance as atmospheric air, when put in rapid motion, we need not be surprised at the effect produced in this instrument by the momentum caused by the immeasurably greater velocity even of what are so imponderable as the waves of light. But, strange to say, when the vessel is made as empty as it is possible to be made, by chemical means, the motion becomes turned in the opposite direction—a phenomenon for which, though it may be difficult to account, I would venture to give the following explanation: As long as any matter remained diffused, probably in the form of aqueous vapor, in the Torricellian vacuum of the glass vessel, its affinity or attraction for the light would draw the motion in the direction that has been described; but when this element in the case had been withdrawn, the omnipresence of Electron, with *his* more rapid motion and his preference for the bright side of the metallic disks, would associate the light with himself and attract the bright side of the disk, and thus draw them in the opposite direction from what the light itself did. By entering into the vacuum in the glass vessel, and being released from the compression of the atmosphere, whatever material atoms might be in union with Electron would have their mutual repulsion greatly augmented, and their undulations being thus driven against the bright sides of the disks, so as to cause their movement.

There may be other ways of explaining the action of this curious and suggestive piece of apparatus, but they all tend to confirm the idea of the existence of matter in a radiant and inconceivably minute condition, diffused through space—in fact, the old and never yet abandoned idea of a universal ether.

That no discovery should have been made hitherto of this radiant form of matter in all the analyses that have been made of atmospheric air is not to be wondered at. There are, indeed, more things in heaven and earth than are dreamed of in our philosophy. Organized and living ova, or germs of many kinds of living organisms, which are now believed—indeed proved—to exist abundantly in the air, and to subserve important functions in nature, were never, nor can even yet be *visibly*, detected in it. And how inconceivably small must those odoriferous particles be which we recognize by our sense of smell! The particles of the scent of game, or of a man's footsteps, for instance—consider how minute they must be to be spread for miles across the ground so as to serve as a sure guide to the dog, who is still more highly endowed in this respect than man. How infinitely numerous and minute these atoms must be, and how completely beyond the power of detection, except through the special sense of smell with which God has provided us! And so the electric or "radiant" matter, as it is called by Mr. Crookes, in an inexpressibly attenuated form, is far more likely to have escaped detection. But if we have faith in this very feasible theory of the universal diffusion of matter, we may find ourselves in a better position for seeing and understanding, to some small extent, God's method in the creation and government of the world.

Taking therefore for granted the existence of radiant matter, or ether—or chaos, as some might call it—we must also admit the probability that this ether is continuous through space—throughout interstellar space, we may say—and that it contains in itself the materials out of which all things were and are made: the stars, worlds, comets, aerolites, and whatever is gyrating and circulating through its vast ocean. If the *proportion* of matter thus held in solution by Electron be inconceivably small, yet as it extends through a space that is, we may say, infinitely great, and is also continually replenished by his solvent power, it may therefore be admitted to be sufficient in amount for the stupendous purposes we have supposed. Out of the matter thus diffused through the ocean of space we can readily believe all things to have been made, the ether itself having been, "*in the beginning*," *created*, but "without form and void," by the fiat of God Himself.

The identity—or rather homogeneity—of the material of which the universal Cosmos is composed may be also inferred from the composition of those aerolites which are from time to time projected, or rather I should say drawn, by gravitation, upon the earth, the substances composing these being found to be quite identical with the components of our own planet. Electron may thus be said to make all the universe kin, and its inhabitants bone of the same bone, and flesh of the same flesh, as ourselves; although the type and model of their physical organization may be very different—indeed must be so—in conformity with the diverse influences affecting them in respect to gravitation, distance from their central suns, periods of their solar circuits, physical or geological condition of the planets, and other astronomical elements. But still we are all formed of the same materials, energized and vitalized by the same electric energy, the same light, and the same heat, and are alike the subjects and children under the government of the same supreme Sovereign.

Matter, as it exists in the ether or chaos, is probably in its simple or atomic, and not in the molecular, form, as it for the most part appears in the earth. We know that Electron *alone* does not conduce to the union, but, on the contrary, to the dispersion or repulsion of the particles of matter. Indeed it is quite possible, by means of electricity, to loose the molecular attraction of different kinds of matter for each other, and to reduce them to their elementary form, as was done in the notable case of Sir Humphry Davy's discovery of the metallic bases of the alkalies and their allies. It seems to require the presence of gravitation—that is to say, the attractive force of a large mass of matter—to enable Electron to exert those chemical powers which constitute so important a part of his properties.

Thus, then, the earth, in its rapid journey through the ethereal ocean of space, like the other innumerable orbs that are circulating there, so acts upon that portion of ether that is sufficiently within the sphere of its gravitating influence (or probably within a distance somewhat beyond the circuit of the atmosphere, or 45 miles) as to admit of chemical—that is to say, molecular—combinations and aggregations of matter being brought into existence in such a condition as to be retained by the attractive power of the planet, and thus added as a permanent and continually augmenting increment of its constitution.

Speculating upon the possibility or the probability of this hypothesis being true, it may be interesting to make an attempt to calculate the amount of increment that would thus be continually added to the mass of our earth.

The elements required for such a calculation are: 1st, the diameter of the earth, with its atmosphere, or (say) the range at which its attractive power would counterbalance the dispersive power of electricity; 2d, the mean distance of the earth from the sun; 3d, the time of the earth's year, or revolution round the sun; and 4th, the proportion of matter that is contained in ether, or, rather, the proportion of matter that can be wrested and precipitated from ether by the chemical and gravitative forces under the influence of which it is brought by the earth's passage through it.

All these have been pretty exactly agreed upon by astronomers, except the last, although it is not improbable that even it too may be ascertained in time. But if it may be allowable to hazard an estimate of it, no one, I think, would say that, whatever may be the absolute proportion of matter in ether, one grain as the reducible portion of it—that one grain to the cubic mile, that is to say one grain to the

thousand millions of cubic feet, would be too large a proportion to assign, and we will solve the problem upon this assumption.

The mean diameter of the earth is 7,912 miles; height of the atmosphere, 45 miles; consequently the diameter of the earth and its envelope is 8,002 miles, and the area of its diametrical section would be:

$$\frac{8{,}004^2}{2} \times 3{\cdot}1416 = 50{,}315{,}870 \text{ miles.}$$

Distance of the earth and sun, 92 millions of miles; therefore 184 = the diameter of earth's yearly circuit round the sun. This multiplied by 3·1416 gives 578,054,400 as the circumference or length of the annual circuit. This again multiplied by 50,315,878, the area of the earth's section, gives 20,002,310,043,428,000 as the number of cubic miles in cylinder made by the earth in its annual course round the sun. This divided by 1,565,800, the number of grains in a ton, gives 1,857,980,378 as the number of tons annually brought within the attractive power of the earth, and as the possible annual addition to its mass. Spread over the globe, with its 197 000,000 of square miles, this would yield about 9·43 tons to the square mile. Allowing 6,080 feet to the mile, a square mile would consist of 36,966,400 square feet. This divided by 9·43 tons, or 147,862,400 grains, would give 0 31 gr. per square foot as the possible amount of matter depositable on the earth; or 31 grains, if we suppose a cubic mile of ether to contain 100 grains of matter. At this rate it would require fifty thousand years for the addition of one ton—say a cart-load—per square mile of matter being added to the surface of the earth.

The greater part of the matter would probably be in the form of water and other fluid substances, which would find their ultimate place of deposit in the ocean, and would not make much recognizable addition to the material of our globe. It is possible, too, that the whole of the ether thus moleculated does not become incorporated with the earth. A portion of it lying next to the outer boundary of the imagined cylinder may probably, though sufficiently within the power of the earth's gravitation as to have its atoms brought within chemical attraction, not be sufficiently near it to be drawn to its surface, and it may thus either drift away in some other direction, or remain in equipoise like the moon, and, also like it, circulate with the earth round the sun.

The foregoing reasoning, if applicable to the earth, must of course also be so to all the other planetary bodies, as well as to the suns or stars of the whole universe, thus affording a glimpse of the stupendous scale on which the theory of development or evolution in this department may be applied. And, as it is believed by astronomers that the stellar system to which we belong is—independently of its other motions—drifting in some to us unknown direction through space, it follows that new and unexhausted fields of ether—"untrodden fields and pastures ever new"—are becoming continually accessible, as the pabulum from which God's universe, or family of worlds, receive their nourishment and growth.

The creation of worlds may thus be understood to be a gradual, continuous, and never-ceasing process; and we can easily believe that among the streams of cosmic dust or stones drifting through space, which must have become concreted or gravitated together from the material atoms of ether, gravitation will still further unite them into larger and larger masses, as, in their motion through space, they come within reach of each other's attraction; and thus it will happen that some large and always enlarging ones will come to assume the rank of planets or planetoids, as we actually find that they *are* now doing in our own solar system. This mode of genesis, too, combined with their rotary motion, will sufficiently account for the almost perfect sphericity of the heavenly bodies.

This long digression—if we can call it a digression—on the subject of cosmogony has mainly arisen, as you may recollect, from the sight of Mr. Crookes' radiometer, and the speculation that so suggestive an instrument is calculated to give rise to.

Having made acquaintance with Electron in two of the forms which he exhibits himself, we may now view him in another and almost as important an aspect, that of heat. Nearly all his operations on matter are attended by a motion or vibration of its atoms resulting in, and in fact constituting, what we call heat. The great genie himself seems gradually to disappear after putting his subject materials into a state of tremulous motion, which gradually subsides, with results more or less observable. He himself may either go into some new arrangement of the materials, or else vanish into surrounding space, though of course he can never be lost or annihilated.

Heat is undoubtedly the most familiar attitude, and the most useful and indispensable form, in which Electron can be viewed; but the purposes he serves, and the benefits he confers on the world, in this character are so well known and appreciated that it is unnecessary even to enumerate, much less to describe them. The analogy, nay the identity, of Electron and heat can be experimentally and otherwise shown in a variety of ways; but there is not time to do more than allude to this interesting department of the correlation and mutual convertibility of physical forces.

Let us for a moment change the metaphor so long kept up, and, by using the magician's power, transform our genie into a wild steed of the desert, careering at his own wayward will through the prairie and the forest—dangerous and difficult to come to close quarters with—admired for his beauty, power, and speed, yet feared and avoided because so untamable and intractable; but when once a material bridle is imposed upon him his speed is greatly subdued, and he becomes the means of carrying man along with him, and of revealing to him all the beauty, grandeur, and wonders of the world. When still further subdued, harnessed, and accoutered, he not only diffuses happiness and life all around him, but can be made to perform a variety of most useful and admirable work, far surpassing in quality and value that of any other creature within the power of man.

Electricity, light, and heat may be said to be a unity in trinity, recondite and mysterious to us, but not altogether incomprehensible—a type or analogy, may we not say, of that greater and still more incomprehensible mystery, the dogma of the divine essence, which forms an important part of the Christian creed, and which it may well encourage and justify us in believing, even although its full comprehension may be beyond our imperfect powers.

Whatever may be thought of the marvelous and beneficent powers of this great genie, as I have attempted to describe them, in reference to the *cosmos*, there is a department of the work assigned him by his creator which is to us (I mean to medical men) as important, if not even more interesting and wonderful. I allude to the services he performs in regard to the *microcosmos*, and in the development and the vital action of all living creatures, bearing, as these of course do, upon the physiological and medical aspects of anthropology. On some of the mysteries of these subjects it is probable that there will fall in time a share of the light which his scientific cultivation is now throwing on other subjects of human interest and utility. But into this department I shall not attempt at present to enter.

The functions of Electron, lying, as many of them do, in the border-land between spirit and matter, have given occasion of late to a contention regarding the respective claims of superiority due to spirit and matter, in carrying on the operations of the world. Leaving the religious and higher aspect of the subject, bearing on the soul, untouched and unaffected, it may be argued on this point that the property of the living body implied by the terms irritability and contractility may be said to lie at the root, and to be in truth the main test and indication, of life. It is the first and the last of the vital actions of the living organism, manifested in the embryo long before consciousness begins, and remaining for some time after death in the heart and other parts, even when separated from the body. This property is undeniably due to the presence of the neura, or nervous power, which is developed and transmitted by the combined action of the organic mechanism, and it is through the medium of Electron in this form that the brain power, the feelings, the senses, and in fact whatever may be said to constitute the life of the animal, are maintained. It in truth may claim to be the *ipse ego* of the individual, rather than the bodily receptacle which is inhabited by it. It is true that the two are inseparable and indispensable to each other, and that they act and react on each other in many ways that are to us inscrutable; but the moment the body loses the power of maintaining the transmitting the necessary supply of its animating spirit their complete separation ensues, and the result is death, dissolution, decomposition, and dispersion of its materials. Was it not an unfortunate boast that Dr. Tyndall made when he said that "we can discern in matter the promise and the potency of all terrestrial life"?—meaning to imply that it is independent of any higher agency than what is inherent in itself. It seems to me, on the contrary, that matter is like clay in the hands of the potter, and that God makes use of some intermediate agent or agents, electricity especially, or by whatever other name it may be called, which is not necessarily nor perhaps universally inherent in matter, to carry on His operations in the world; and it is by this power, in fact, that all things are kept together in their position and arrangement. Were *it* withdrawn, by the Almighty Creator, the property of cohesion would cease; all things would fall asunder into dust, and would probably be scattered into space like the sand or dust in the desert.

Yes! the supremacy belongs to spirit, and not to matter. All the admirable and elevating works of art, of poetry, literature, and science; all the inventions and discoveries of man, his heroic achievements, his virtues, his religious and philanthropic enthusiasms; these, and it must be added also all their opposites of a malign description, are the result of spiritual influences—literally of spiritual influences—residing in and energizing his person. And all the infinitely more admirable and beautiful forms, both animate and inanimate, in which the material of the world is moulded are the work of that infinitely greater Spirit who predominates and rules over all.

In His government of the universe God has chosen to endow the great spirit Electron with attributes in some degree similar to some of those belonging to Himself, and He has given him potencies in accordance with these attributes; but behind, and upholding, and above them all, there dominates God's own supreme existence and will. Indeed, it is impossible to conceive that matter itself, even though acted upon by all the natural or spiritual influences we know of, could mould and fabricate itself into the infinite and yet normal varieties of forms and substances, both living and inanimate, which we see around us.

On the contrary, the living world of which we form a part presents everywhere a never ceasing miracle of Almighty power and wisdom, although our bodily eyes cannot see the hand that performs the miracles, and the sublime significance of which we fail to comprehend only from its very familiarity and our own innate selfishness and want of spiritual discernment. Thus says Tennyson:

"Flower in the crannied wall,
 I pluck you out of the crannies!
Hold you here, root and all, in my hand,
Little flower; but if I could understand
 What you are, root and all, and all in all,
 I should know what God is, and man is."

If he is a fool who has said in his heart that "there is no God," by what other name shall we call those who say or insinuate that Electron is all the God that they can recognize as being required in the world; as if a being, however powerful, whom man can force to obey his commands, as his submissive servant, could at the same time be the Sovereign Lawgiver of the Universe. The idea is heathenish and absurd. It is in kind, though not in degree, as much idolatry, or a breach of the first commandment, as the worship of stocks and stones, or of the sun, moon, and stars, or even of heroes or demigods, or of the classical deities of the ancients. Their reasoning in the matter ought rather to be: "If a servant or minister in the economy of Nature has been endowed and intrusted with such attributes and powers, how infinitely more powerful and highly endowed must be the Creator Himself, the source of all this power!"

In connection with this subject, it is only a few years since there raged a long and vehement controversy on what was called spontaneous generation, one party affirming and the other denying that the forces of Nature alone, more especially electricity, can originate life and organization in dead matter. But, after years of laborious and well-directed experiment and investigation, the conclusion acquiesced in by all but a few of the most prejudiced partisans is that not even the minutest monad can be produced, except from a parent or previously existing individual of the same kind. God's method, however, and His ordained laws in the never-ceasing and exuberant creation and evolution—to use the new term—of all living things, are beyond the reach of our penetration, notwithstanding the gradual advances that are apparently being made in this direction by *savants* and theologians. Such are "the *depths* of the riches both of the wisdom and the knowledge of God; how unsearchable are His judgments, and His ways past finding out!"—Rom. xi., 33.

As a fair specimen of the reasoning and drift of those who support the idea of spontaneous generation, I shall quote the words of an article on the "Relation of Darwinism to Other Branches of Science," by Mr. Ball, the Astronomer Royal for Ireland, in the November number (p. 83) of *Longman's Magazine:* "At the outset of Darwin's theory," he says, "we encounter a very celebrated difficulty. His theory requires life to begin with, but how did that life originate? I need hardly remind you of the celebrated controversy which has taken place on this subject. It has been contended that life can never be produced except from life, but just as stoutly has the opposite view been maintained. Can it be possible that the wondrous and complex phenomena known as life are purely material? Can a particle of matter, which consists only of a definite number of atoms of definite chemical composition, manifest any of those characters which characterize life?" . . .

"Unusual, indeed, must be the circumstances which will have brought about such a combination of atoms as to form the first organic being. But great events are always universal. Because we cannot repeatedly make an organized being from inert matter in our test tubes, are we to say that such an event can never once have occurred with the infinite opportunities of Nature? We have in Nature the most varied conditions of temperature, of pressure, and of chemical composition. Every corner of the earth and of the ocean has been the laboratory in which these experiments have been carried on. It is not necessary to suppose that such an event as the formation of an organized being shall have occurred often. If in the whole course of millions of years it has once happened, either on the land or in the depths of the ocean, that a group of atoms, few or many, have been so segregated as to have the power of assimilating outside material, and the power of producing other groups more or less similar to themselves, then we have no more demands to make on the 'Theory of Spontaneous Generation.' The more we study the actual nature of matter, the less improbable will it seem that organic beings should have so originated."

All this seems to me to be only a *petitio principii*, or begging of the question, which there is absolutely no ground for acceding to. It reminds one of the boast of Archimedes: "Give me a fixed place to stand upon, and I will move the world." "Concede to me," these reasoners say, "that matter can form and fashion itself into a living being, and I will dispense with your God, and depose him from his throne of supremacy." The premise, if it does not mean this, at all events tends to lead some of its upholders to this and other conclusions which are opposed to the first principles of religion. Such conclusions, however, would be a mistake, even although the premises were proved to be true, for these would by no means do away with the irresistible and unavoidable recognition of an all-pervading, unceasing, and intelligent energy presiding over and throughout the universe.

As a safeguard against the dangerous and atheistical tendencies referred to, we should, in accordance with the instinctive promptings of our own nature, of all nature, and of reason and revelation, believe in God as the Creator and Governor of the Universe; and in gratitude for all that we owe to Him we ought, in the words of Christ's summation of the moral law, to love Him "with all our heart, and with all our soul, and with all our mind." But if scientists choose to make their abode in the cold shade of Agnosticism, or the still colder, darker, and more inhospitable region of Atheism, the loss and damage will be to themselves and to those who adopt their belief—a belief which, if it became general in any country, would, as has been proved by the past history of the world, destroy the basis on which its moral government is founded, and sooner or later bring degradation, misery, and ruin in its sequence.

Given life and organization, given their inseparable combination with Electron—*but given by whom?*—and we must admit that the latter plays a most important part in the use and the functions of the powers, and attributes of all living beings. But without these postulates, and the conditions necessary for their existence, Electron would be but a blind and reckless, however powerful and all-pervading a spirit. In the case of any planet, or say that of our own moon, for instance, which is believed to be so destitute of water that whatever portion of this it may contain is drawn by gravitation, and retained in the interior, so that it cannot appear upon the surface; and the absence of this indispensable element of animal and vegetable life would account for the arid, dismal, and death-like appearance which our pale-faced satellite, without any indication of a change of seasons, exhibits when viewed through the post powerful telescopes. *Which she at present presents*, I say, because if the hypothesis suggested be true it is possible that in the course of ages a sufficiency of water may be moleculated and attracted by the moon's own power of gravitation, to supply her with enough of this vital element to enable her, by the will or fiat of God, and through means of Electron, to become at last adapted for and endowed with such a variety of the tribes of animal and vegetable life as that which now enriches and adorns her suzerain, if not also her parent, the earth.

The Darwinian doctrine does not necessarily lead to Atheism, and it is after all only a theory, admirable, ingenious, and suggestive in its way, but far from being so reliably and in every point true as to have the right to supersede and stamp out the old and universal beliefs which have hitherto governed mankind.

In conclusion, it may be said that Electricity as a science has now passed its stage of infancy and childhood, and is entering upon that of youth and adolescence. Long the plaything and pet of philosophers and medical men, for whose nursing and education it has hitherto brought them but scanty return, it has now grown into importance in a social, industrial, financial, sanitary, legislative, and legal point of view, and has consequently fallen under the protection of the State, and the control of financiers, lawyers, inventors, mechanicians, and speculators, and is expected by many to prove an *El Dorado* to those who have the skill and the Spirit to take possession of the hidden treasures which Electron, like Aladdin's Genie of the Lamp, has in his keeping. But it is quite possible, if not indeed probable, that if the noble genie be overdriven and hounded on by a band of mercenary and unscrupulous men, he may, like Samson, when forced to grind and make sport for the Philistines, bring down their financial structures in ruin on the heads of many of them—a disaster which indeed has already occurred in several instances.

The form of allegory, or slightly interrupted allegory, in which this paper has been cast is of course not like a scientific, or logical, or deductive treatise. It is, and professes to be, nothing more than a semi-fabulous and romantic account of the matter on which it treats. By a wave of its magic wand it sweeps away doubts and difficulties, and fills up gaps or dangerous and defective places which stand in its way. As Browning says—

"It brings the invisible into play,
 By letting the visible go to the dogs."

By an instinctive stroke of the imagination it fills in whatever is wanting to render its narrative as life-like, truth-

like, and acceptable as possible; and yet it is quite possible that it may convey the elements of truth as really as many a dry and laborious philosophical dissertation. By the quaint and grotesque points of view in which it presents the subject, it tends to bring out new features and aspects of it which might be overlooked in the ordinary light of scientific treatment.

And there is another point of view in which some might be disposed to regard it favorably. If not in accordance with the most recent views in theology, it is at least in harmony with the older and orthodox idea of the personality of God. It strikes the same key-note of impersonation, and is in accordance with the style of language employed in the Bible, and with the way in which an old Hebrew prophet might have declaimed "Sed eheu quam magno intervallo" on such a subject. Nor is it out of harmony with the mode of expression still made use of, and still most readily understood, by the great mass of mankind regarding God's operations in the world.

[THE ASCLEPIAD.]

THE FIRST ELECTRICIAN—WILLIAM GILBERT, M.D.

By BENJAMIN WARD RICHARDSON, M.D.

IF there be one old town in England more interesting than another to the historical scholar, it is Colchester. Every class of scholar may find some interest there, and we of medicine need not be behind the rest. In Colchester we shall find the birthplace and the final resting-place of the illustrious pioneer in science who gave us the word electricity, and the first true idea of the power. The pioneer in question was William Gilbert, M.D., friend and favorite physician of Queen Elizabeth.

The best account of this man is supplied in "The History and Antiquities of the Most Ancient Town and Borough of Colchester," by Philip Morant, M.A. MDCCXLVIII.

Gilbert wrote his own name Gilberd. He was the son of Hieron (Jerome) Gylberd, gentleman, a native of Hintlesham in Suffolk, but afterward a burgess of Colchester; made so in 1528. William was born in the year 1540. He studied both in Oxford and Cambridge, and afterward traveled on the Continent, where (according to Morant) he had conferred upon him the degree of Doctor of Physic. Dr. Munk, however, has gathered from Mr. Cooper, the learned author of the "Athenæ Cantabrigienses," that he was of St. John's College, Cambridge; that he proceeded B.A. 1560; was elected fellow of St. John's, 21st March, 1560–61; M.A. 1564; M.D. 1569; and senior fellow of his college 21st December, 1569.

Gilbert settled in London when he was thirty-three years of age, and commenced practice as a physician. He became a Fellow of the Royal College of Physicians, passed through the office of Censor and Elect, and in the year 1600 was made President.

That he practiced his profession with great success is clear from the evidence of all who have written concerning him. He was received, says Morant, with the highest favor by Queen Elizabeth, whom he served as chief physician, and from whom he received a legacy, the only legacy she left to any one. He also, for the short period between the Queen's death and his own, acted as physician-in-chief to James I. By his will he left all his books, globes, and cabinet of minerals to the College of Physicians.

Morant states that there was a portrait of Gilbert in the Schools Gallery at Oxford in his time, which portrait showed him to have been tall of stature and of cheerful countenance. It is from this portrait that the engraving on this page was probably taken, although we have now no direct evidence of the fact. The plate has been kindly lent to me for autotype copy by permission of the Treasurer of the Royal College of Physicians.

From this plate as the center of the subject, Mr. Arthur Ackland Hunt produced, a few years ago, a very fine historical painting, representing Gilbert making an experimental demonstration in electricity, before Queen Elizabeth. In the picture Sir Walter Raleigh, Drake, and Burleigh contrast admirably with the ladies of the Court, who, if I remember rightly, are more interested in a young courtier than in the experiment.

Gilbert's house in Colchester was anciently called "Tymperley's" or Tympernell's. In Morant's time it "was the same as Serjeant Price, late Recorder, lived in, and still possessed by his widow and relict, Bridget Price."

Where Gilbert resided while in London we have no record; but that he had every facility for his own line of research there cannot be reasonable doubt. To that research, so remarkable for its originality, and so important in its future bearings, I now direct, briefly, the attention of the reader.

The peculiarity of the work which first strikes us lies in a word. Gilbert is the man who gave to us the word *electricitas*. It had been known, long before his time, that the rubbing of amber (electron) caused amber to attract some light bodies. Gilbert, whose great line of investigation was on the magnet, differentiated between the attraction exerted by the magnet and that exerted by the excited amber. He connected also the kind of attraction evidenced through amber with that produced by exciting glass, wax, jet, and other substances since known as electrics. His great work "De Magnete," published in 1600, becomes thus the basis of all our electrical science from that date. Galileo, Bacon, Thomson the historian of the Royal Society, Priestley, and in our later time Hallam, all bear witness to the solid quality and originality of the De Magnete.

For preparing this short memoir I have, with the kind assistance of my friend Mr. James Menzies, made a study of this book, some portions of which are sure to be of interest to all scientific and medical readers.

De Magnete opens with a preface to the candid reader and student of magnetic philosophy, a preface so good that it admits, scarcely, of curtailment. In it Gilbert pours forth the spirit of true philosophy. In it he shows that he was well acquainted with and a master of the experimental method of research in natural science. In it he demonstrates that he was actually carrying out, in practice, that which the author of the *Novum Organon*—who, upon natural things, wrote, as Harvey said, "like a Lord Chancellor"—was putting on paper as a series of speculative disquisitions and projects.

Thus in the strictest sense of the term Gilbert might be called the father of modern experimental science.

With Mr. Menzies' kind and learned aid I give this remarkable preface in full, for the first time, I believe, in English dress.

PREFACE TO THE CANDID READER AND STUDENT OF MAGNETIC PHILOSOPHY.

"Since in the discovery of the secrets, and in the inquiry into the hidden causes of things, stronger proofs can be obtained from reliable experiments and demonstrated arguments than from the probable conjectures and opinions of the ordinary professors of philosophy; since, therefore, the famous substance of that great magnet, our common mother the earth, hitherto wholly unknown, and the conspicuous and eminent forces of this globe of ours, may be the better understood, I propose to begin from the common magnetic, earthy, and iron bodies, those substances of our globe which we can grasp with our hands and perceive with our senses, and then proceed to demonstrable magnetic experiments, and so penetrate, for the first time, into the innermost parts and secrets of the earth. For after very many of those things which have been obtained from the heights of mountains, the depths of seas, the profoundest caverns and buried mines have been seen and understood, then at last we shall have learnt the true substance of the earth. To the investigation of magnetic force (such, indeed, are the wonderful and surpassing qualities of the bodies known to us) have I given a great and prolonged attention. Nor have I found this labor idle and unfruitful, inasmuch as during the progress of my daily experiments, new and unexpected properties have revealed themselves, and my love of knowledge hath so much increased from the diligent survey of things, that I have essayed to show forth the very interior of the terrene globe and its true substance on magnetic principles; to reveal unto men the earth (our common mother), and to point it out as with the finger, by true demonstrations, and by experiments manifest to the senses.

"And as geometry ascends from sundry very simple and easy principles to very high and difficult conceptions, by which the wit of man climbs above the firmament, so our teaching of magnetic science first sets forth in convenient order certain obvious facts; out of these more remarkable ones come to light; and at last, in sure order, the concealed and greatest secrets of our globe are opened, and the causes of those things known which, either through the ignorance of ancient, or the neglect of recent, times, have been overlooked and unknown. But why should I, in so vast an ocean of books, by which the minds of ingenious men are troubled and fatigued, through which very silly productions the herd of unreasoning men are intoxicated, rave, are puffed up, and create literary broils, and while declaring themselves to be philosophers, physicians, mathematicians, and astrologers, neglect and despise men of learning; why should I, I say, add anything new to this republic of letters, and expose this philosophy, glorious, seemingly new and incredible, on account of so many things hitherto unrevealed, to be condemned and torn to pieces by the ill words of such persons as are pledged to the opinions of other men, or are the foolish corrupters of good arts, bookish laymen, grammarians, sophists, wranglers, and froward individuals of the meanest kind? But unto you almost alone, you honest students of philosophy, who seek knowledge not from books only, but from things themselves, I commend these principles of magnetism, set forth in a new mode of philosophizing.

"And should it not seem fit to some to assent to sundry opinions and incredible statements, they may nevertheless contemplate a great array of experiments and discoveries (such as all philosophy ever flourisheth in), which have been searched out and demonstrated by me with much care, watchfulness, and cost. In them rejoice, and to good purpose enjoy them, if ye be able. I know how difficult it is to give freshness to old things, brilliancy to the antiquated, light to the dark, grace to the despised, credibility to the doubtful; how much more difficult is it to obtain and establish some authority for things new and unheard of, and which are opposed to all the beliefs of men! Nor for that, however, do I care; since I think it is to few that the philosophic spirit hath been vouchsafed. Whoever desires to make trial of the same experiments, let him handle the substances not unskillfully and carelessly, but wisely, aptly, and in a business-like way; and let him not (when he fails of success) begin to find fault with my inventions, for nothing hath been set forth in this book which hath not been examined and many times tried and repeated by me.

"Many things in the reasonings and hypotheses will, perchance, at first sight seem very hard to be received, yet I doubt not but that at length they will obtain authority from the clear proofs given. Wherefore, in magnetic science, they who advance furthest, trust most in, and receive most profit from, the arguments adduced; nor in this science will anything easily become clear to any one in which all or nearly all points are not known. Almost the whole of this department of natural science is new and unheard of, except what a few writers have delivered concerning certain familiar properties of the magnet. Wherefore, I but little approve of the aid obtained from the ancient Greek writers, because neither the poor Greek arguments nor the Greek words avail to demonstrate or cast any light upon the truth. For our magnetic teaching is at variance with most of their principles and received opinions.

"Neither have I brought to this work any craft of eloquence or adornment of words, but this only have I done that things difficult and unknown may be so handled by me and set forth in that style of writing and in those words absolutely necessary, that they may be clearly understood. I sometimes, therefore, use certain new and unusual words, not that by means of the childish veil of words, shades and darkness should be cast upon facts (as the alchemists are wont to do), but that hidden things, which have no name, and which have never before been understood, may be plainly and clearly delivered by me.

"After describing our magnetic experiments, and making known the like elements of the earth, I proceed to the general nature of the whole globe itself, wherein it is allowed us to philosophize freely and with the same liberty which the Egyptians, Greeks, and Romans formerly used in publishing their opinions; whereof very many errors have been handed down to later authors, and in which smatterers still persist, and so wander, as it were, in perpetual darkness. To each of these ancient and earliest fathers of philosophy, Aristotle, Theophrastus, Ptolemæus, Hippocrates, and Galen, let due honor be paid; such are the writers who have diffused knowledge to subsequent ages; but our time hath disclosed and brought to light very many facts which they also, had they been alive, would doubtless have accepted. Wherefore we hesitate not to deliver, in an argument founded on truth, those things which have been discovered by us after prolonged experiment."

WILLIAM GILBERT, M.D.—ELECTRICIAN.

THE BOOK.

Such is the preface to this wonderful book. Its first chapter supplies a description of the magnet and of magnetic virtues. In its second chapter it introduces us to the word and the power electricity. It explains that not only will the magnet attract some bodies brought near to it, but some other things will do the same, after they have been excited by friction. Amber (*electron*) is one of the substances which can be thus excited; jet is another of the same kind; but amber came first into knowledge as evincing this remarkable property.

"Amber," Gilbert says, "holds flies, ants, and other small creatures shining in eternal sepulchers"—*æternis sepulchris relucentes*. There was a touch of poetry in William Gilbert.

The bodies of this nature may, then, be called electrics, and the property they present may be called the electric, or electrical. There are many bodies which act as electrics, besides amber and jet. The diamond, the sapphire, and some other precious stones, glass, sulphur, mastic, sealing-wax, and resin are electrics.

Gilbert seems to have discovered that glass, sulphur, and wax are electrics, his mode of discovery being as simple as it was effective. Small strips of metal suspended from their centers were the best objects. To them the excited electric was presented, and the attraction was the proof of the electrical action.

He was very exact in noting the conditions under which electrical action could be best observed. He found that it is always most active when the air is dry and when the wind is north or northeasterly. Moisture destroys the effect, and even the presence of the breath is sufficient to impair it. He made an attempt to electrify water, and by presenting

an electrified body to drops of water, produced a conical shape in the round drop. He discovered that if an electrified rod were brought near to the dense smoke rising from a burning substance, the smoke was attracted. He suggested that electrical attraction was due to the electrical fluid or effluvium rushing from one substance to another of similar kind, and cohering, as two drops of water cohere and run into one. He suggested also, on this matter, a distinction between magnetism and electricity.

"The difference between magnetic and electric force is, that all magnetic bodies attract by their mutual strength, while in electric bodies the electric attracts only; the body attracted is not changed by its natural force, but is drawn spontaneously by the nature of the material of which it is composed. Bodies are drawn toward electric bodies in a straight line toward the center of electricity; but the magnet attracts the magnet only at the poles directly, at other points obliquely and transversely, even as they adhere and hang together. Electric motion is the motion of an accumulation of matter; magnetism, of arrangement and order. The globe of the earth is collected, and coheres by electricity. The globe of the earth is directed and moves by magnetism, and at the same time it also coheres and is welded together in its inmost parts, so that it becomes solid."

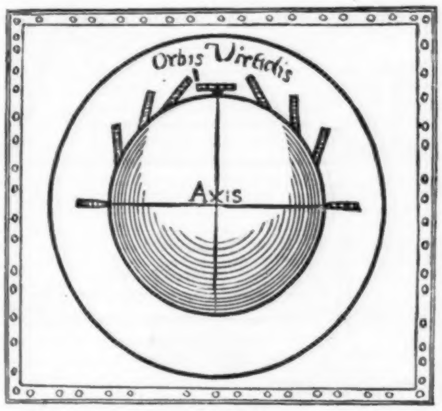


Fig. 1.

To these remarkable indications must be added, however, others as remarkable in respect to the magnet. There is something startling in certain of the chapters relating to the electrical properties of the earth and the attraction of the planet for substances upon its surface. He gives a drawing (Fig. 1), of which I present a copy, in which he depicts a magnetic globe or orb, and indicates how magnetic poles or bars arrange themselves in respect to the axis of the globe.

One of the most interesting chapters on this matter of terrestrial magnetism is chapter xvii. in book i., "*Quod globus terræ sit magneticus*": "The globe of the earth magnetic; the magnet; and how the magnetic stone has all the primary forces of the earth; and that the earth through the same forces maintains its fixed position in the universe."

This chapter begins:

"Before the cause of magnetic motions, the demonstration of facts concealed during so many ages, and experiments (those true foundations of human philosophy) are brought to light by us, that new and unheard of opinion of ours must be stated and laid before the eyes of the learned; which, when it has been debated and supported by certain probable reasons, it will indeed be established as firmly as anything which hath ever been seen or proved in philosophy by ingenious arguments or mathematical demonstrations."

Gilbert's opinion, thus prefaced, is, that the earth with its masses of rock and water, and all its parts, whether seen or

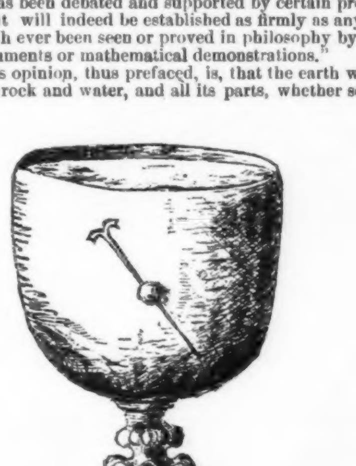


FIG. 2.

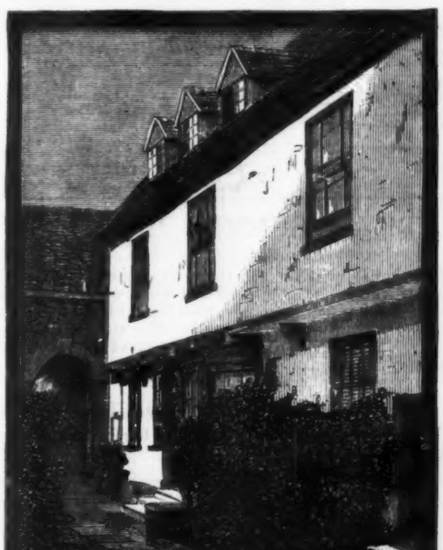
hidden from human sight, is a magnet, and is possessed of all the qualities known as magnetic. "I consider," says he, "the earth to be a solid substance, firmly cohering in its primary form, and (as in the other globes of the universe) endowed with a well knit form, which maintains its position and fixed polarity, and revolves with a determinate motion from an implanted power of movement, even as the magnet, beyond all bodies seen by us, possesses a true and genuine character, little injured and deformed by external evils, which is a homogeneous and true part of, and which has been separated from, the body and volume of the earth.

"Such is our earth in its interior parts, a body possessing a homogeneous magnetic nature; and on such a perfect foundation stands the whole nature of terrestrial things, which under our diligent scrutiny everywhere shows itself, such as in all the magnetic metals of the earth, in veins of iron, in all kinds of clay, and in most varieties of earth and stone; whereas the pure element of Aristotle, and the main terrestrial phantasm of the peripatetic philosophers (that simple substratum of all things) is rude, inert, cold, dry, dead, of no vigor, hath never appeared to any one except in dreams, and is of no effect in the nature of things. To speak plainly, all the solid earth, wherever it is seen; even that earthy matter which has not been purified from coarse and humid elements, such as clay, mire, and material gathered from putrid substances; whether they have been injured by the imperfection of various mixtures, or fallen to pieces through their grossness like marl, all these, whether they have been prepared by fire alone, or are freed from their superfluous moisture, are attracted by the magnet, and as by the magnet so also are other bodies magnetically attracted and set in order by the earth itself; and through their implanted force do they arrange themselves according to the method and order of the world. So also every fragment of the earth, by true experiment, shows all the force of the magnetic nature, and obeys the globe and universal principle of our earth throughout its various motions."

In another part of his work he gives the preceding diagram to show how a needle, floated by means of a cork in a goblet of water, exhibits both variation and declination if it be rendered magnetic (Fig. 2).

In chapter xii., book i., he compares magnetic force to vital force. Magnetic force is life or resembles life, and surpasses human life in many respects, while it is bound in the organic body.

"The magnet is wonderful in innumerable experiments, and is, at it were, a living force. This is the one remarkable virtue of those which the ancients considered to be life in the heavens, in globes and stars, in the sun and moon. For they considered that such varied motions could not be maintained without a divine and living force; or that without it, vast bodies could revolve in fixed terms, or that wonderful powers could be infused into other bodies through this primary form of the globes themselves. The ancients, the whole Platonic school, the Egyptians, and Chaldæans, affirm that the universe is endowed with life. On the other hand, Aristotle thinks that the elements are inanimate, the stars animate. I myself think that the whole creation, all globes, all stars, and the glorious earth itself, are governed from the beginning by a proper and determinate life, and have their movements of self-preservation. Although there



GILBERT'S HOUSE AT COLCHESTER.

are not in the stars, the sun, or the planets any organs which can be recognized by us, yet they live. If there be anything of which man can boast, assuredly it is life; and God Himself (by whose will all things are ruled) is intelligence, is mind. Who is he, then, that will demand organs in the divine mind, which overpasses all the framework of organs, and is not restrained by material organs? But in the different bodies of the stars, the implanted force acts otherwise than in those divine things which are supernaturally ordained; and in the stars the force acts otherwise than in animals; in animals otherwise than in plants. Certes, it were a miserable condition of the stars, a base lot of the earth, if that glorious dignity of life were denied them which hath been granted to the worm, the ant, the moth, the plant, and the toadstool."

LAST DAYS AND WORKS.

Morant is careful to tell us that Gilbert left behind him another work, "*De Mundo Sublunari Philosophia Nova*," which work, still in manuscript, was retained in the library of Sir William Boswell, Knight. Nearly fifty years after the death of its author it was published from Amsterdam, by his brother William Gilbert, Junior, a proctor in the Court of Arches, with a dedication to the unhappy Prince Henry of Wales, friend of Walter Raleigh, and son of James the First.

According to the same biographer, Gilbert invented two ingenious instruments for seamen to find out the latitude without the help of sun, moon, or stars. The instruments were made public by Thomas Blondeville, in a quarto work published in London in 1602.

The annual pension left by Queen Elizabeth to our philosopher physician was not long enjoyed by him. The queen died on March 24, the philosopher on November 30, 1603. He was never married.

In many respect Gilbert resembled Harvey, particularly in having been much beloved and honored by his brothers, of whom he had four—Ambrose, William, Jerome, and George. Over his tomb in the church of the Holy Trinity, Colchester, the brothers Ambrose and William placed a Latin inscription, which my learned brother Munk has copied into his Roll of the Royal College of Physicians, and which I supplement in English:

AMBROSE AND WILLIAM GILBERD HAVE PLACED THIS TOMB,
IN MEMORY OF BROTHERLY PIETY,
TO WILLIAM GILBERD, SENIOR, GENTLEMAN, AND DOCTOR OF MEDICINE.
THIS THE ELDEST SON OF JEROME GILBERD, GENTLEMAN,
WAS BORN IN THE TOWN OF COLCHESTER,
STUDIED THE ART OF MEDICINE AT CAMBRIDGE.
PRACTICED THE SAME FOR MORE THAN THIRTY YEARS AT LONDON,
WITH SINGULAR CREDIT AND SUCCESS,
HENCE, CALLED TO COURT, HE WAS RECEIVED WITH HIGHEST FAVOR BY QUEEN ELIZABETH,
TO WHOM, AND TO HER SUCCESSOR JAMES, HE SERVED AS CHIEF PHYSICIAN.
HE COMPOSED A BOOK CELEBRATED AMONG FOREIGNERS
CONCERNING THE MAGNET, FOR NAUTICAL SCIENCE.
HE DIED IN THE YEAR OF HUMAN REDEMPTION 1603, THE LAST DAY OF NOVEMBER,
IN THE 63D YEAR OF HIS AGE.

The monument bearing the above epitaph remains in fair preservation in the old church of the Holy Trinity; and hard by still stands Gilbert's house, once the Tymperleys'. Friend Henry Laver, of Colchester, surgeon there, and excellent antiquarian scholar, to whom I am much indebted, has taken a photographic view of the residence as it now is, which view Bertram Richardson has transferred to paper, as a fitting conclusion to this short history of First Electrician.

DETECTION AND DETERMINATION OF PICRIC ACID.

By G. CHRISTEL.

THIS compound forms yellowish white leaflets which take up ammonia on exposure to the air and assume a deep yellow color. The solutions of trinitrophenol in dilute acids, in chloroform, and carbon disulphide are colorless. If the solution in chloroform is evaporated to dryness, there remains a colorless residue which is colored deep yellow by a drop of water. If a yellow (ammoniacal) picric acid is dissolved in a little water, mixed with two or three volumes of either, and shaken up, a part only of the acid is taken up by the ether, and further additions of ether dissolve scarcely any coloring matter. The addition of acetic acid does not alter this behavior, but after adding a little sulphuric acid the entire picric acid may be extracted with ether. Ammonia withdraws the dissolved picric acid from ether; and the golden-yellow ammonium picrate is insoluble in ether. Chloroform removes only a part of picric acid from its pure watery solution or from one which has been acidulated with sulphuric acid. In searching for picric acid it is therefore best to acidulate with sulphuric acid and exhaust by shaking up with ether.

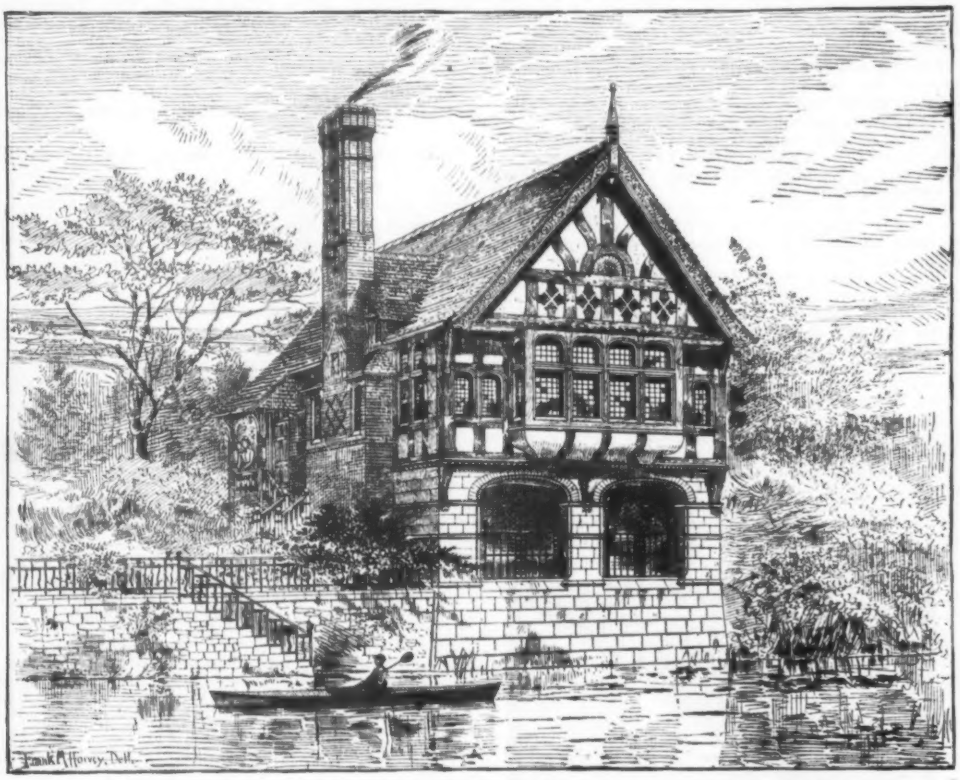
If to a solution of picric acid or ammonium picrate in water we add neutral lead acetate or copper sulphate, there is no precipitate, but on further adding a little alkali (ammonia) there is formed with lead acetate a reddish yellow precipitate, and with copper sulphate a greenish precipitate. On the other hand, $\frac{1}{10}$ milligramme picric acid dissolved in 5 c. c. water with a few drops of basic lead acetate becomes strongly opalescent, and gives subsequently a slight but distinct yellow precipitate This precipitate is decomposed by dilute sulphuric acid. If the same precipitate is submitted to prolonged treatment with water, a part of the picric acid is dissolved, while there remain an apparently more basic compound of a deep orange-yellow.

The yellow coloring-matters of *Quercus tinctoria* (quercitron bark) and of *Broussonetia tinctoria* (fustic) behave in a similar manner with the salts of lead. These and analogous coloring matters are distinguished from picric acid thus: they are neither changed by potassium cyanide nor reduced by potassium stannite. Their precipitates are never so pale yellow as that of picric acid. The soluble aniline yellow of commerce dissolves to a reddish yellow liquid, which if much diluted appears of a pure yellow. It is very imperfectly precipitated by basic lead acetate, not changed by potassium cyanide, but turned at once to a purple by hydrochloric acid.

If a solution of trinitrophenol, not too dilute, is mixed with an aqueous solution of methyl green, there appears a green precipitate which in excess of water dissolves to a bluish green liquid. It is soluble also in acetic acid and in other acids. With organic bases (alkaloids) picric acid gives precipitates, as is well known, but they are not suitable for its separation. On boiling solutions of picric acid with permanganate, considerable quantities of the latter are reduced. If to an aqueous solution of picric acid there is added stannous chloride, a yellowish brown precipitate falls down, but if a little ammonia be added, or if potassium stannite is used, the liquid becomes red from the formation of picramic acid. If to a solution of barium chloride there are added a few crystals of caustic baryta and a solution of picric acid, not too dilute, there is formed a red precipitate. Sulphureted hydrogen reddens an alcoholic solution of picric acid. The same effect is rapidly produced by ammonium sulphide. By the action of zinc and dilute sulphuric acid upon picric acid there is formed a yellowish red turbid liquid. If this is decanted off from the zinc, mixed with an excess of alcohol (ethylic), allowed to stand for some time, and filtered, the liquid becomes greenish, and changes first to a violet blue and then to a reddish violet. If even a very small quantity of picric acid (much less than 1 milligramme) or of an alkaline picrate is heated with hydrochloric acid and stannous chloride, allowed to cool, a trace of potassium chlorate added to the mixture slightly heated, the liquid becomes first greenish yellow and then a fine blue, but an exceedingly trifling excess of potassium chlorate destroys the color. In presence of organic matter this reaction is not distinct. One of the most sensitive and trustworthy reactions is the well-known transformation of picric acid into red phenylpurpuric acid on heating with potassium cyanide. Trinitrocresol, in like manner, forms cresylpurpuric acid on treatment with potassium cyanide. If an aqueous solution of picric acid, not quite saturated, is mixed with potassium sulphocyanide and the mixture heated, there appear in the liquid (which at first remained clear) numerous yellow crystalline needles, which reflect incident light with splendid green and red colors. If the crystals are separated from the liquid, dried, and touched with an incandescent body, they explode with extreme violence. Nitrogenous tissues (wool, silk) take a permanent yellow in an aqueous solution of picric acid; absolute alcohol, hydrochloric acid, dilute caustic alkalies, and aqueous ammonia withdraw the picric acid, partially or entirely, from such tissues. The residue from the evaporation of the ammoniacal solution thus obtained is particularly fitted for the basic acetate of lead reaction and for that with potassium cyanide. Animal charcoal, if added in small quantities to a solution of picric acid, does not decolorize it, but larger quantities entirely withdraw picric acid from its solutions.

To detect picric acid in beer Christel evaporates 200 c. c. to the consistence of a sirup; introduces the residue into a small flask, adds 50 c. c. of alcohol at 90 per cent., lets it stand for twenty-four hours, during which the whole is re-

peatedly well shaken up, filters, extracts again with 30 c. c. alcohol, evaporates the mixed filtrates to the consistence of a sirup, adds to the residue 4 to 5 drops of dilute sulphuric acid (1 : 3), and then mixes it with 5 to 6 volumes of ether in a test-tube closed with a cork. After the mixture has undergone strong and prolonged shaking the ether is decanted, 2 or 3 drops of sulphuric acid are added to the residue, which is again shaken out with ether. The mixed ethereal solutions are evaporated in a porcelain capsule at common temperatures, the residue is diluted with water to 5 to 10 c. c., filtered, and neutralized with ammonia. The solution thus obtained can be further tested as above. Christel determines picric acid colorimetrically, comparing the intensity of the color of a solution of phenylpurpuric acid obtained from the substance under examination with the intensity of solutions prepared simultaneously and the same conditions from different but known quantities of picric acid. The procedure admits of determinations as close as 1 milligramme picric acid in 100 c.c.—*Zeitschrift f. Analytische Chemie und Archiv der Pharmacie; Chemical News.*



SUGGESTIONS IN ARCHITECTURE.—A SUMMER HOUSE.

A COUNTRY HOUSE.

THIS house was designed for a site commanding a particular view, which accounts to some extent for the large amount of balcony accommodation provided on the front, as well as for other arrangements of plan. The materials proposed are red bricks for the wall facing, red tiles for the upright tile hanging, and brown for the roofs, the gables being finished in cream-colored rough cast and the woodwork of bays and balconies painted white.

Our illustration is taken from a colored sketch by the architect, Mr. Walter Millard, of London.—*The Architect.*

A SUMMER HOUSE.

THIS summer house was erected in 1882, for David Johnson, Esq., of Barrel Well House, Chester. It consists of a room 28 ft. by 19 ft. 9 in., with open timbered roof, to be used principally as a music room or summer house. The front portion under the principal room is used as garden house, the entrance into the upper part of building being on a higher level of the sloping bank. The work was designed by Mr. Thomas M. Lockwood, architect, of Chester.—*Build. and Eng. Times.*

CONCRETE FOR MARINE CONSTRUCTIONS.

IN the Aberdeen Breakwater and the Harbor Works at Brest, concrete blocks of moderate dimensions were adopted, weighing in the former case from 7½ tons to 24 tons, and in the latter 100 tons each.

As an example of the use of extremely large blocks, a short reference may be made, says *Engineering*, to the manner in which a considerable length of deep water quay wall has been constructed at Dublin. The position of the works is extremely well sheltered, and interruptions due to bad weather are consequently reduced to a minimum. The contents of each block average about 193 cubic yards, which at 14 cubic feet to the ton gives a weight of about 370 tons. Each block is about 29 ft. in height, and is built in wooden casings to the section of the wall, battered on the face, and with horizontal offsets at the back, each block representing 12 lineal feet of quay wall built to a level of 3 ft. above low-water. The blocks consist of rubble masonry set in cement concrete, gauged in the proportion of one part Portland cement to seven parts sand and very coarse gravel or shingle, and are built upon a specially constructed wharf at a short distance from the site they are intended to occupy permanently. A block takes from three to four weeks to build, and is considered sufficiently consolidated to move after ten weeks. A large iron pontoon or float, also of special construction, is used for lifting and transporting the blocks. This pontoon (see Fig. 1) is 130 ft. in length, 48 ft. wide,

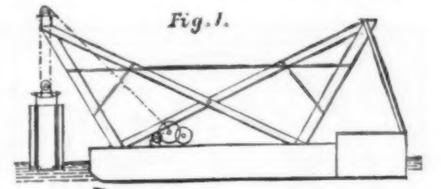


Fig. 1.

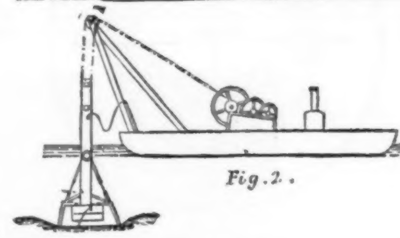


Fig. 2.

and 14 ft. deep, and is provided with two pairs of massive and lofty shear-legs, one pair forward, the other aft. The cross-head of the former, which is 54 ft. above the deck of the pontoon, carries two sets of heavy four-sheaved pulleys, through each of which, and a corresponding pair of hanging pulleys, a pitch chain is reeved. The lower pair of pulley blocks are furnished with projections which grip the upper tee-heads of four round iron suspension bars passing through the masonry, and provided with tee-heads on their lower extremities, bearing on cast iron girders or washers built into the bottom of the block.

The after shear-legs support a counterbalance consisting of a tank filled partly with concrete and partly with water; the latter, by being pumped into or out of the tank, affords the principal means of lifting and setting the blocks in their position. The first part of the lowering, however, is accomplished by means of the pitch chain already mentioned, which is connected to powerful crab winches on the deck of the pontoon. These winches, together with a centrifugal pump and several surging-heads, are driven by a 14 nominal horse-power engine.

The foundation for the blocks is prepared first by dredging, the excavation being subsequently completed, and the bottom very carefully leveled by means of a large diving-bell (see Fig. 2), which is also of special construction and

SUGGESTIONS IN ARCHITECTURE.—A COUNTRY HOUSE.

consists of a cast iron chamber 20 ft. square and 6 ft. 6 in. inside height, with a vertical tube and air lock. The bell or chamber is suspended from a suitable shears placed on an iron float containing the engine, air pumps, winches, etc. With a diving chamber of this description, the bottom—which when ready for the block is about 26 ft. below low water, and has an area of about 250 square feet—can be leveled with the great accuracy absolutely necessary for the satisfactory setting of such large blocks in quay walls where irregularities in the face are inadmissible.

With the aid of the special appliances above described, an average of 400 lineal feet of blocks can be laid in still water per year, which is equivalent to 6,560 cubic yards, or, allowing 306 working days to the year, about 22 cubic yards per day. The actual progress has been somewhat less (about 364 lineal feet per annum), owing to slight interruptions of various kinds.

The cost of the special plant required for the lifting, transporting, and setting of the blocks has been as follows:

Floating shears	£18,783
Block wharf	4,610
Chain testing machine, moorings, and sundry small items, about	2,607
Total	£26,000

The cost of the blocks standing on the wharf is given as 16*l*. per lineal foot, or about 19s. 8d. per cubic yard for labor and materials.

Lifting, transporting, and setting the blocks, including maintenance of shears, float, and block wharf, also shifting moorings, etc., has been 3*l*. 10s. per lineal foot of block, or, say, 4s. 4d. per cubic yard. If interest at 5 per cent. per annum be added to the cost of the plant (26,000*l*.), and one-fourth the first coast deducted as the approximate selling value of the plant, at the end of five years, the proportion of cost of special plant will be 16s. per cubic yard, and similarly, at the end of ten years, 10s. per cubic yard, and at the end of fifteen years 8s. per cubic yard.

Summarizing these results for convenience of comparison, the cost of the various items connected with the block-work is as follows:

Quantity of block-work deposited in place per year	6,500 c. yds			
Approximate coast of special plant required for manipulating the blocks	26,000*l*.			
	£	s.	d.	
Cost of blocks, materials, and labor	0	19	8	p. c. yd.
Lifting, transporting, and setting of blocks, including maintenance of float and block-wharf	0	4	4	"
Proportion of cost of special plant at end of five years	0	16	0	"
Proportion of cost of special plant at end of ten years	0	10	0	"
Proportion of cost of special plant at end of 15 years	0	8	0	"
Total cost at end of ten years' work, exclusive of cost of leveling foundations	1	14	0	
Total cost at end of fifteen years' work	1	12	0	"

The large size of the blocks used at Dublin involved the leveling of the foundation with great care and accuracy; for this purpose the large diving chamber before described has been found to work satisfactorily; its cost, however, was considerable, amounting to 5,454 *l*., which would preclude its use on any but works of considerable extent. The cost of excavation, including the maintenance of bell, float, and machinery, is given at 3*l*. per lineal foot of block, which is equivalent to about 3s. 8d. per cubic yard of block-work. If to this is added the proportion of the cost of this item of special plant, after fifteen years of continuous work, which amounts to about 1s. 8d. per cubic yard of block, the total cost of excavating and preparing the foundations will be about 5s. 4d. per cubic yard of block-work, or about 51*l*. per block.

The details of the system adopted at Dublin have been most carefully elaborated by Mr. B. Stoney, the engineer of the works, from whose valuable paper on the subject most of the preceding information has been extracted.

The breakwater at Kustendjie, on the western shore of the Black Sea, affords an instance of the successful use of 30 ton concrete blocks. Each block is 6 ft. high by 5 ft. wide, and of a length equal to the width of the breakwater, which is 18 ft. at the bottom and 12 ft. at the top; the blocks are laid with a slope toward the shore of 45 deg. from the vertical, somewhat similar to those used in the Manora breakwater at Kurrachee (which will be subsequently referred to), and laid on a similar foundation of loose rubble stone. The concrete used at Kustendjie consisted of the following:

	Parts.
Broken stone	5½
Sharp sand	2½
Portland cement	1

Taper bolts 2 in. in diameter were used to lift and lower the blocks, the nuts and washers remaining permanently in the block; this arrangement, however, does not compare favorably with that adopted at Dublin and elsewhere. The blocks were lifted and set by means of a timber gantry carrying a traveling winch. The foundation was first roughly leveled and the operation subsequently completed by divers with the aid of iron set squares. The cost of this breakwater is not given, so that the method of construction employed cannot be compared in this respect with those already referred to.

The blocks were lowered into their places when from twelve to fourteen days old.

CHEHAB'S HYDRAULIC CLOCK.

THERE has been observed for a few days past at the Garden of the Tuileries a monumental clock with its back to the terrace that borders the water. It was invented and constructed by an interpreter of the African army, Mr. Chehab, who obtained permission from the Minister of Fine Arts to set it up in this place in order to make his invention known and appreciated.

The clock runs without weights or springs. It is provided with a bell, and not only marks the hours and minutes, but also the days of the week and month.

The power necessary to run it is derived from water. In spite of the dimensions of the two dials (one of them 4 and the other nearly 7 feet in diameter), the power used is very slight, and the pressure that the city water reaches in the apparatus is utilized for nothing. In fact, this water is received in a small reservoir about a foot and a half in height by about a foot in width, which is provided with a waste-pipe which keeps the level always constant, despite the flow that occurs at the lower part through a pipe about a quarter of an inch in diameter.

It is easy to see that, under such circumstances, the volume and pressure of the water that escapes through this pipe remain constant, whatever be the variations that occur in the general conduit.

The power disposed of is therefore absolutely invariable, and this is an essential point where a clock is concerned. The power, produced by the fall of water issuing from the reservoir, is necessarily quite feeble, but we shall see that, thanks to the ingenious manner in which it is used, it suffices to actuate the entire system of a clock of large dimensions.

To make the system understood, we may compare it to

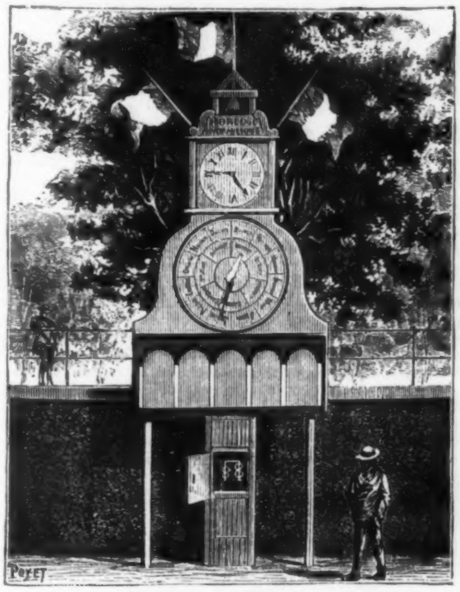


FIG. 1.—CHEHAB'S HYDRAULIC CLOCK.

the movement of a turnspit. The only difference consists in applying the motor to a mover that has the least power and greatest velocity, that is to say, to what in the turnspit represents the fly-wheel, instead of applying it, as is done in all clocks, to a mover having the most power and least velocity, that is to say, to the barrel.

In Mr. Chehab's mechanism the mover consists of two small turbines, A and B, which the jet of water causes to revolve with rapidity. The axis of the wheel, A, carries an endless screw which actuates a cog wheel whose pinion transmits the motion to other gear wheels, C. The velocity is thus considerably diminished, and power is consequently gained. The clock is regulated through a small governor by varying the position of its balls. The striking arrangement is actuated by the second turbine, B, which drives a series of gearings, D, analogous to the preceding.

The principal advantage of a clock of this kind is that it costs but little, and, besides, that it never has to be wound

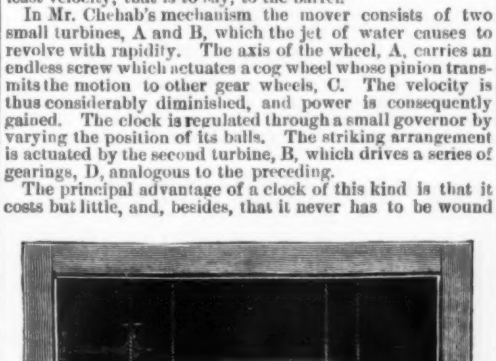


FIG. 2.—DETAILS OF THE MECHANISM.

up. It is only necessary to have a fall of water of a foot and a half at one's disposal, and this water may afterward be employed for other purposes.

In the majority of cities this system will certainly render decided services, for it will permit of increasing the number of city clocks (which in certain quarters are sometimes wanting) at a slight expense.—*La Nature.*

A HUGE drum, intended for one of the Philadelphia and Reading Company's mines, was cast a short time since at Pottsville. The drum will be 14 feet long, 19 feet in diameter at the center, and 12½ feet at the ends when put together. It took eight men five weeks to prepare the mould. It was cast in two parts, each weighing 32,000 pounds, taking 37,000 pounds of molten iron, the extra iron going for stays and wastage. One minute and ten seconds was all the time required to pour out the whole 37,000 pounds.

WATER-POWER WITH HIGH PRESSURES AND WROUGHT-IRON WATER-PIPE.*

By HAMILTON SMITH, JR., M.Am.Soc.C.E.

FOR the purpose of supplying the placer mines in California with water, many ditches were built on the western slope of the Sierra Nevada, taking their source high up in the mountains, and delivering the water on the tops of the foot hill ridges, at elevations from 1,000 to 3,000 feet above the great valley of California, formed by the Sacramento and San Joaquin rivers. In many cases, the mines for which these aqueducts were constructed have been exhausted or abandoned, and their water is now largely used for power for quartz mining and milling, and for other purposes.

When manufacturing in California assumes large proportions, doubtless most of the motive-power will be obtained from these mining ditches, which in the aggregate will afford several hundred thousand horse-power.

The problem presented has been in general the utilization of a small quantity of water—as few of these ditches carry more than 70 feet or 80 cubic feet per second—with high heads ranging from 200 to 600 feet The Barker reaction wheel (or mill) was first used to a limited extent, but was soon abandoned, owing to its uneconomical use of water. Turbines were then employed, but with unsatisfactory results, as the great speed of the wheel shafts, due to the velocity of high heads, resulted in excessive wear and tear upon the bearings of the wheel-shafts, and also upon the gates and guides. Partial turbines, or tangential wheels,† were used with better success. In some cases, large overshot wheels were built, one at the Sierra Buttes mine having a diameter of 65 feet. A wheel of very simple form, called the "hurdy-gurdy," was introduced some twenty years or more ago, and has almost entirely superseded other hydraulic motors; it has been improved from time to time, until the latest models give an astonishingly high percentage of useful effect. The first part of this paper will be devoted to a description of various styles of the hurdy-gurdy wheel, and an account of some of the methods by which the water is conducted to them, and the power transmitted from them.

THE HURDY-GURDY WHEEL.

The hurdy-gurdy, as first used, was a narrow wooden wheel or disk, built upon a cast iron spider keyed upon the wheel-shaft, as shown by Fig. 1. The faces of wheels of

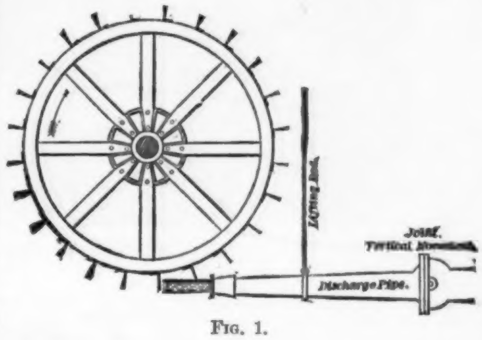


FIG. 1.

considerable diameter were from 4 to 6 inches wide; the buckets were square iron castings bolted to the rim, against which the water escaping under pressure from the nozzle impinged. Wheels of this sort were made as large as 21 feet in diameter; when of this size, they were sometimes stiffened by light iron tie rods, running from the rim to collars upon the shaft. With high heads, the face was banded with wrought iron, to prevent the jet from splintering the wood. This simple type possessed the following advantages:

First. Small cost of construction.

Second. Comparatively light foundations were required.

Third. Slow speed of wheel-shaft with high heads, which could be modified at will by change of diameter.

Fourth. Horizontal wheel shaft obviating the necessity of bevel gearing.

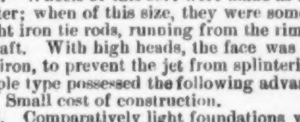
Fifth. The weight of such large wheels, with a high velocity at the rim, was of service in steadying motion of machinery driven, thus affording a cheap form of fly-wheel.

Sixth. Almost absolute immunity from accidents, the wear and tear being practically *nil*.

These advantages are common to a l the forms of the hurdy-gurdy now in use, with the exception of that due to the large wheel. With this flat bucket, the impact force of the jet was only in part utilized, which in no case could be over 50 per cent. of the theoretical power of the water; in practice, an efficiency of not over 40 per cent. could be obtained. The most advantageous periphery speed, measured on the center line of the buckets, was about 45 per cent. of the velocity of the escaping jet due to gravity $\left(\cdot 45\,(2gh)^{\frac{1}{2}}\right)$. Mr. Ross E. Browne, of the University of California, with such flat buckets, obtained 40·4 per cent.‡ as the maximum useful effect on the wheel-shaft, with a periphery speed of about one-half the velocity of the escaping jet (doubtless measured at smallest diameter of the nozzle). B ⅜ inch nozzle was used, with a head of 50·2 feet, in this experiment. D'Aubuisson describes somewhat similar *horizontal* wheels as being frequently used in the A ps and Pyrenees, the water being led to them by steeply inclined troughs. Probably the use of a jet, escaping under high pressure from a pipe, is a California invention or modification.

The first improvement upon this simple form consisted in putting flanges on the sides of the rim, with curved sheet-iron buckets between, as shown by Fig. 2. A number of

FIG. 2.



experiments were made by the writer with a wheel of this pattern, 17¾ feet in diameter; effective heads from 312 to

* Read before the American Society of Civil Engineers.

† These wheels are really modifications of the hurdy-gurdy; the jet generally striking on the inside of the rim, against fixed curved buckets.

‡ Bulletin No. 1, College of Mechanics, University of California, 1883, by Prof. F.G. Hesse and Ross E. Browne; to which valuable contribution on water motors, reference will several times be had in this paper.

336 feet; with buckets 4 inches deep, 4 inches wide, set 12 inches apart. Nozzles of various kinds were used; some with a taper, giving a coefficient of discharge from 0·944 to about 1; and others with square-edged thin steel ring set in the end of the discharge-pipe, whose coefficients of discharge ranged from 0·60 to 0·64.

EXPERIMENTS SHOWING DISCHARGE OF WATER THROUGH VARIOUS CIRCULAR NOZZLES AND RINGS. 1874.

No.	No. of nozzle or ring on sketch.	Diameter.	Effective head.	Q.	Velocities of jet. Actual.	Theoretic.	Coef. of discharge.	Remarks.
1	1	·0531	322·3	·323	145·8	144·0	1·012	
2	3	·0850	314·4	·774	136·4	142·2	·960	
3	3	·0850	312·1	·750	132·7	141·7	·944	
4	5 uncut.	·0868	316·1	·813	137·4	142·6	·963	No. 5, uncut.
5	5 cut-off.	·0868	332·6	·831	140·4	146·2	·960	No. 5, cut at smallest section.
6	5 cut-off.	·0868	335·9	·833	140·8	147·0	·958	
7	7	·1017	317·9	1·111	136·8	143·0	·957	
8	7	·1017	315·6	1·110	136·7	142·5	·959	
9	2 ring.	·0597	316·3	·240	85·7	142·6	·601	
10	4 "	·0647	312·6	·511	90·7	141·8	·640	
11	4 "	·0647	312·2	·509	90·3	141·7	·637	
12	6 "	·1823	130·1	1·528	58·5	91·4	·640	Total head in this experiment.

The nozzles and rings are shown by sketches in Fig. 3. The nozzles and discharge-pipe into which they screwed were of cast-iron, first turned and then smoothly polished. The rings were of saw-plate steel, with square edges; the discharge-pipe, at the end of which the rings were set—Nos. 2 and 4—was a smooth casting. The effective heads for Nos. 1 to 11, inclusive, are given within 2 feet of the truth. Q, for Nos. 1 to 11, was determined by the flow over a sharp-crested iron weir, 0·866 feet long, by formula of J. B. Francis modified; the chances are that Q is underestimated 2 or 3 per cent. Diameters were measured at smallest section of nozzles. These experiments indicate that with great heads

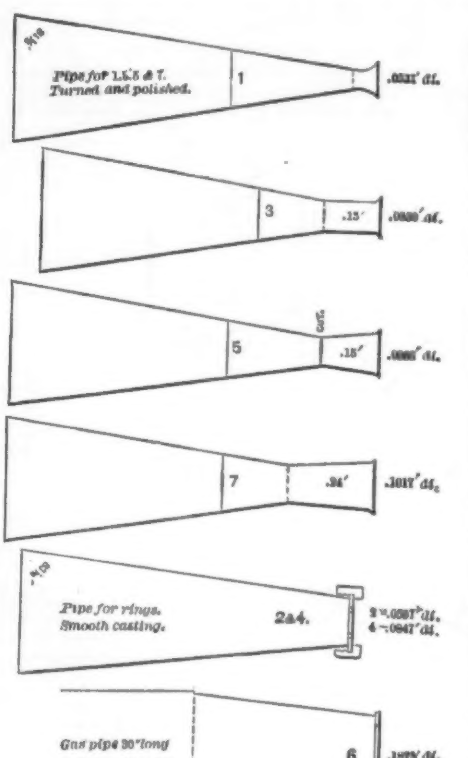


FIG. 3.

divergent mouth-pieces or adjutages have but slight effect. No. 5 had a divergent end of a length 1·8 times diameter, and gave coefficient of 0·963; when cut at smallest section, coefficient remained 0·960 and 0·958. No. 7, with a divergent end of a length 2·4 times diameter, had a coefficient of 0·957 and 0·959. The annular square edged mouth-pieces were narrow, especially Nos. 4 and 6, and yet show a nearly full contraction of the escaping jet.

The jet through the rings gave a somewhat better effect than from the tapered nozzles, although the jet was slightly farther away from the wheel with the ring nozzles than it was with the tapered ones.

With small nozzles, the maximum useful effect was about 35 per cent. with a bucket speed of $0.35\,(2\,g\,h)^{1/2}$; with larger nozzles, the maximum efficiency was about 46 per cent. with a bucket speed of $0.45\,(2\,g\,h)^{1/2}$. The highest power developed in these experiments was 17 horse-power, which, for such a heavy wheel as that used, was too little work to show the greatest efficiency.

These tests proved that the best bucket speed depends not upon the velocity of the jet, measured at the smallest area of the nozzle, but practically upon the velocity due to gravity. The ratio of best speed to $(2\,g\,h)^{1/2}$, for the same amount of work done, was about the same with the rings as with the tapered nozzles, although the velocity at the smallest section of the nozzle was one-half greater than through the rings.*

A similar wheel—diameter 12·58 feet, total head 130·1 feet, ring nozzle 0·1823 foot in diameter, driving a 10-stamp crushing-mill, average weight of stamp 694½ pounds, average drop 0·768 feet, number of drops per minute 62·2—developed 10 horse-power of actual work, showing an efficiency of 44½ per cent. Allowing for loss of head in pipe and friction of machinery, this would indicate a duty on the wheel-shaft of fully 50 per cent.

* This is doubtless due to the increased velocity of the vena-contracta at its smallest diameter, after the jet has escaped from the ring.

Fig. 4 shows the next important improvement, being the Knight wheel, made of cast iron, with curved buckets set close together. The nozzle is a narrow slit, curved to fit the outer edge of the wheel, the idea being to have the jet strike the buckets at as close a distance as is possible. With muddy water, the wear on this form of nozzle becomes objectionable; with considerable heads, a jet of circular section will probably show better results. This wheel has met with great favor, a large number of them being now in use. At the

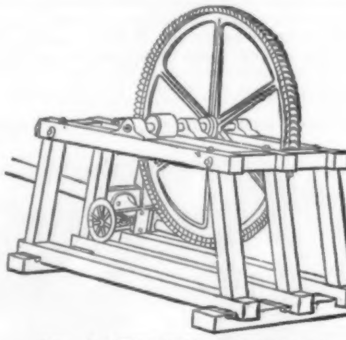


FIG. 4.—THE KNIGHT WHEEL.

Providence gold quartz mill, near Nevada City, a Knight wheel did actual work amounting to about 54 per cent. of the power of the water, in addition to overcoming friction of machinery. Mr. Browne found, in experimenting with curved buckets (section arc of circle), a maximum efficiency on the wheel-shaft of 65·6 per cent., with a periphery speed of about 44 per cent. of theoretical velocity of water. This was with a ⅜-inch tapered nozzle, and a head of 50·4 feet.

Fig. 5 shows the Collins wheel, which, when placed at the Providence mill (before spoken of), as a substitute for the Knight, did the same work with $\frac{5}{11}$ the amount of water. This mill has 40 stamps, each weighing 750 pounds, drop 8 inches, 92 drops per minute, aggregating work of lifting the stamps 1,840,000 minute foot-pounds. There are also one rock-breaker and sixteen Frue vanners (concentrators), requiring fully 8 horse-power (264,000 foot-pounds) more,

FIG. 5.—THE COLLINS WHEEL.

making in all say 2,104,000 minute foot-pounds (64 horse-power). This work is done by a Collins wheel, 6 feet in diameter, running 250 turns a minute; the water is conducted to it through 1,856 feet of wrought-iron pipe (1,156 feet being 22 inches, and 700 feet 15 inches in diameter), and discharged under a head of 389 feet through a 1⅞-inch nozzle. The water used amounts to very nearly 136 cubic feet per minute. Assuming 2 feet head as lost by friction in pipe, 387 × 136 × 62·4 = 3,284,237 foot-pounds per minute; 2,104,000 ÷ 3,284,237 = 64 per cent.,* as useful effect in moving machinery. The wheel is quite a distance from the main line of shafting, the power being transmitted by belts. Allowing for losses of friction in belting, lines of shafting, cams, and stamps, there would result an efficiency on this wheel-shaft of over 70 per cent.

The latest, and probably the most efficient, bucket thus far discovered is known as the Pelton wheel, a perspective view of which is shown by Fig. 6, and a section through the

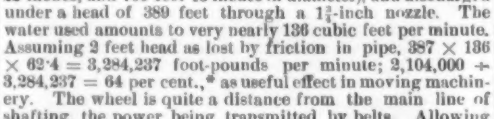
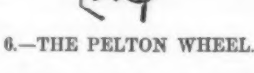


FIG. 6.—THE PELTON WHEEL.

bucket by Fig. 7. The invention consists in splitting the jet as it strikes the bifurcation of the bucket. The line of the jet should be tangential to the wheel. Where much

Fig. 7. Section through Bucket.

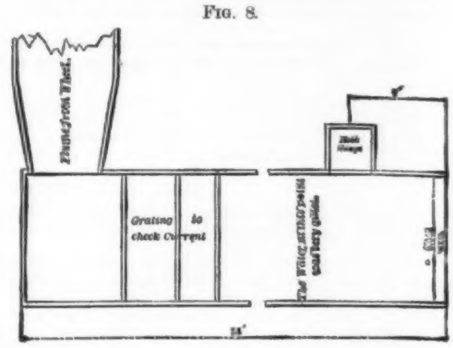


power is needed, two discharge-pipes can be used, and any desired form of nozzle applied. Mr. Browne found with

* The writer determined amount of water used at this wheel by the flow through a standard aperture. The work done is only given with approximate correctness, but in all probability without serious error.

one of these wheels, which was not built on the most approved model, the following results: Wheel 15¾ inches in diameter. Nozzle, ⅜ inch, tapered. Head, 50·2 feet. Maximum efficiency on wheel shaft, 82½ per cent. Best speed of bucket, very nearly one-half the velocity of the jet (substantially $\frac{1}{2}\,(2g\,h)^{\frac{1}{2}}$.) With the same nozzle, and a head of only 8 feet, he obtained a useful effect of 78 per cent. With a ¼-inch nozzle, best result was 75.6 per cent.; with a $\frac{7}{16}$ inch nozzle, best result was 82.6 per cent. A number of tests of various hurdy-gurdies was made at Grass Valley some months since, under charge of disinterested parties. These experiments appear to have been properly made, with a Prony brake and weir measurement of water, and showed for the Pelton wheel, while doing 107·4 horse-power of

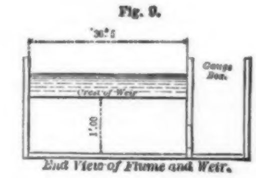
FIG. 8.



work, under a head of 386 feet, the wonderfully high efficiency of 87·3 per cent.

These experiments were made with a Pelton wheel 6 feet in diameter; nozzle, 1·89 inches in diameter; supply main, 6,900 feet long, 22 inches in diameter, with a head of 386½ feet above nozzle. The water used was measured over an iron weir, ¼ inch thick, 3·42 feet long, without end contractions, as shown in Fig. 8 and Fig. 9. The depth, as

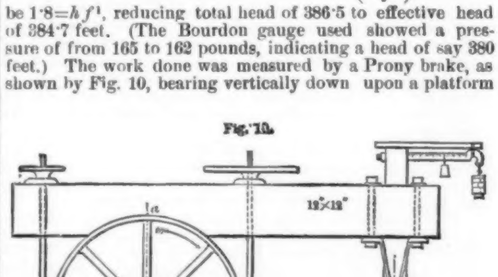
Fig. 9.



End View of Flume and Weir.

measured by a Boyden hook-gauge, reading to 0·001 inch, was 0·4146 ft. The discharge by Fteley's formula of $Q=3{\cdot}31\ l\ h^{\frac{3}{2}}+0{\cdot}007\ l$, would be 2·709 cubic feet per second. With water section of 3·04×1·5, velocity of approach was 0·6 foot; with $ha=\frac{V^2}{2g}$ head due to this velocity would be 0·0056; to be safe, 0·0056×2=0·0112=ha=additional head due to velocity of approach. Fteley calls in general $h\,a=1{\cdot}5\frac{V^2}{2g}$. This makes a total head of 0·4146+0·0112=0·4258; then with same formula as before, Q=2·819 cubic feet per second. The head lost by friction in pipe, with formula $V=50\left(\frac{d\,h\,f}{l}\right)^{\frac{1}{2}}$ would be $1{\cdot}8=h\,f^1$, reducing total head of 386·5 to effective head of 384·7 feet. (The Bourdon gauge used showed a pressure of from 165 to 162 pounds, indicating a head of say 380 feet.) The work done was measured by a Prony brake, as shown by Fig. 10, bearing vertically down upon a platform

Fig. 10.



scale, and which showed a weight of 200 pounds upon the scale-beam when the brake-gear was suspended by a cord from the point, a, immediately above the wheel-shaft; this made a constant minus correction of 200 pounds. The friction-pulley had a face of 12 inches, was kept wet by a jet of clear cold water, did not heat much, and ran without much jumping.

There were thirteen tests made, showing pretty even results. The first four were as follows:

	a. Weight shown by scale.	b. Net weight (—200 lb).	c. Revolutions of wheel-shaft per minute.	bc.
1	665	465	254½	118,342
2	665	465	255	118,575
3	660	460	256	117,760
4	660	460	256½	117,990
		Totals......	1,022	472,667
		Means......	255½	118,167

The arm of the brake (AB) was 4·775 feet from center of wheel-shaft to point resting on the scale, and hence described a circle with a circumference of 30 feet. The work done

was therefore (118,167×30) 3,545,000 minute foot-pounds= 107 4 horse-power. The theoretic power of the water was (2·819×60×384·7×62·4) 4,060,253 foot-pounds. Useful effect was therefore, 87·3 per cent. The effective head being 384·7 feet, the velocity of the escaping jet due to gravity would be 157 feet per second, or 9,420 feet per minute. The wheel was six feet in diameter, hence circumference = 18·85 feet; with 255½ turns per minute, ratio of bucket speed to theoretic velocity would be 51 per cent., or $0·51\ (2gh)^{\frac{1}{2}}$ The nozzle of 1 89 inch diameter had an area of 0·0195 square feet; hence its coefficient of discharge was 0·92. The hook-gauge was only 2 feet back from the weir, and doubtless gave a slightly too small depth of water; the coefficient of 0·92 for the nozzle, as above, is rather small, also indicating slightly greater discharge than that estimated. However, these experiments show in any event a duty of fully 85 per cent., which agrees with the results found by Mr. Browne.

The other competing wheels showed a much lower rate of duty. An inspection of a small Pelton wheel running at a very high velocity showed that it ' carried over" a surprisingly small amount of water. This fact proves the excellence of this particular form of bucket.

The writer at first found it difficult to believe in such high percentages, but from the evidence before him is now satisfied that, with a wheel properly designed, and with heads above 100 feet, or even less, a larger amount of work can be got out of water by the hurdy-gurdy than by any other form of wheel. Water pressure engines* may possibly give as good or better results, but their great cost (due to the solidity with which their working parts and column must be built, to withstand the shock of arresting the moving water) will prevent them from coming into general use.

Where a wheel is so placed that it will at times be submerged by back water, the turbine is, of course, preferable to any other wheel. In other regards, however, the hurdy-gurdy possesses almost every advantage.

The chief misapprehension as to the hurdy-gurdy has been in considering it simply as an impact, and not also as a pressure wheel, which, when properly designed, as Mr. Browne points out, it clearly is.

NOTE.—An examination of a hurdy-gurdy with either flat, recessed, or curved buckets, while at work, shows that the wheel "carries over" a large amount of water, the force of which is consequently lost, and in fact becomes an additional load to lift.

Mr. Browne says: "When a jet of water strikes a stationary bucket, as shown in Fig. 11 or Fig. 12, so soon as

Fig. 11.

Fig. 12.

the motion becomes permanent, the wedge-shaped portion of the water, shaded with horizontal lines, becomes practically stationary. When such a bucket is used for a wheel, it is plain that the shaded portion of the water is 'carried,' and must subsequently escape with nearly the full velocity of the bucket." The wedge that is inserted in the Pelton bucket takes the place of this "dead" water.

* The water pressure pumping engine, for some time in use at one of the shafts on the Comstock lode in Nevada, is said to show an efficiency of over 90 per cent. There are now three of these engines at work in the State of Nevada, and a paper fully describing them would be of much interest.

OAK DESTROYED BY LIGHTNING.

RARELY have we seen so complete destruction of a noble tree by lightning as that of which we give an illustration, from a photograph by Messrs. Field & Son, obligingly sent us by Mr. Harrison, of the County Seed Establishment, Maidstone. The tree was struck on July 5, in the Mote Park near that town. Our illustration shows the destruction of the bole, some 8 feet in girth. A larger photograph, sent at the same times, shows how the main limbs were riven and scattered in all directions.—*The Gardeners' Chronicle.*

OAK STRUCK BY LIGHTNING.

EDUCATED OXEN.

THE performances of horses, dogs, monkeys, and other quadrupeds exhibited at circuses, etc., are certainly astonishing, but it is still more wonderful to see a pair of oxen trained to such perfection as to perform the most wonderful feats. A Mr. Rueger, trainer and circus-master, has succeeded, by wonderful patience and labor, in training two Durham oxen to such perfection that they can be exhibited as well as trained horses. They are by no means as elegant in their movements as a horse, but this is still another proof of the great labor it required to instruct these cumbersome, heavy animals.

The whip is of no avail with them, but patience, choice food, dainties, and words of praise do more than a whip. The annexed cut, taken from the *Illustrirte Zeitung*, shows the different tricks, etc., performed by the oxen. The most difficult and interesting of these is rocking on a board, or "see-saw," about one foot wide. The smaller animal, "Jim," first steps on one end of the board, gradually moves to the middle and then rocks the board, exhibiting his abilities as solo performer. He then moves beyond the fulcrum to enable his comrade, "Bill," the larger of the two animals, to step on the board; and then "Jim" moves backward, and this is the most difficult part of the feat, toward his end, until the board is properly balanced; and then the two animals rock it with great uniformity and regularity. It is a most comical sight to observe the expression of the animals' faces, as they seem to be fully aware of the important part they are taking in the programme of the evening.

EDUCATED OXEN.

A REMINISCENCE OF DR. DALTON.*

By CHARLES CLAY, M.D.

I THINK, but am not quite certain, that it was in the year 1816 or 1817 I was an apprentice to Kinder Wood, Surgeon, 51 King Street, Manchester. About that time the Marsden School of Medicine began its operations, of which my master had the Midwifery Class jointly with Mr. Partington, Jordan and Bluntstone on Anatomy, Dalton on Chemistry, Fawdington on Surgery, Davies on Botany, and some others. I mention this, as it has often been stated that the Pine Street School of Medicine was the first in Manchester, *which is not correct.*

Among other lectures I was advised by my master to attend the lectures on chemisty, by Dalton, which I did. The course consisted of ten lectures, which were to be extended afterward. I thus became a pupil to Dalton. At that time he was busy experimenting on gases, and he asked my master if he could suggest any plan by which he could obtain some of the gases of the coal-pits, more especially what was usually called fire-damp. Mr. Wood replied, he had a friend in Oldham whose pits were unusually troubled with fire-damp and had had many serious explosions; and if Dr. Dalton was very anxious he would try, *but how?* The Doctor then suggested some bottles filled with water, then taken into the mine and emptied, and when emptied well corked. Mr. Wood said he thought he would send his apprentice to his friend with bottles and instructions, and he felt sure it would be attended to correctly. *I was then asked, and willingly volunteered to go.*

Four wine bottles, which the Doctor thought sufficient, were got, and a wine basket that just held them, with a piece of sealing-wax in my pocket and four tightly-fitting corks greased at the ends, to be inserted. I started for Oldham with the note. Mr. Wood drove me as far as Hollinwood; from thence I walked to Oldham, and with some difficulty found

* A paper read before the Manchester Literary and Philosophical Society, April 15, 1884.

the gentleman, who was just starting on a journey. After reading the note he smiled, and asked me to get into his gig. He drove right to the pits, explained the matter fully to his manager, and left me in his care. The underlooker was then signaled from the pit, and soon after made his appearance, black enough from head to foot. Careful instructions were given to him on taking the basket. I interfered, and said I had come to see the matter myself, and therefore wished to go into the pit. The manager smiled, and asked me if I had ever been in a coal pit; I said no, but I was ready to go. So in the end we prepared to start; I was placed in the tub with the underlooker, who went with me one leg in the tub and the other outside, to guard the descent, as there were no conducting-rods. On progressing downward I felt a curious sensation as though I should be sick, and I sensibly felt I was descending rapidly on looking at the sides of the pit; but when the light failed the motion appeared reversed, as though I was going upward. In a few seconds more I felt the elasticity of the rope, which felt as though it elongated and contracted alternately, and which produced something like seasickness. On the tub reaching the floor of the mine I got out, and was surrounded by about half a dozen black-faced mortals, full of curiosity as to what I could want there. What had the bottles in them? Was it gin? My conductor replied, "*Nobbut water;*" loud laughter followed. "Neaw, lads," says the conductor, "look handy; two of you go with me and this lad as far as we can with candles, and then stop for orders."

The conductor took the basket, preceded by one of the men. I followed, and a man followed me; in this order we marched along the mine. I felt the iron rails beneath my feet. After proceeding for a considerable distance I heard a noise like thunder, and inquired what it was. The conductor said only the wagons. "Now," said he, "stand close to the wall." I had no sooner done so when four wagons of coal were pushed past by lads. We then proceeded as before; at last we got to a point that the conductor called out *Halt*, and put out all candles but one that was put into a lump of clay and fastened on the wall of the passage.

"Now go on carefully." Soon after we came to a turn and entered another drift, where we had to creep in a bent position. My breathing at this time became difficult, I felt great oppression about my chest, and the perspiration was profuse all over my body. The conductor called out to me, "Heaw dost feel, lad?" I said, "Not very well!" "Con theaw manage a bit further?" I replied, "I think I can." We then proceeded, but in a short time we stopped. The conductor declared it was not safe to go further. "Neaw, lad," said he, "get done what theaw has to do." He gave me the basket; I felt for the bottles, took one and gave a cork to one of the party, and having emptied the water out gave the bottle to be corked well, instructing him to force it in well, and so on with the other three bottles, which when finished I said I was ready to return, the bottles being put mouths downward into the basket.

We then began to retrace our steps, and every few seconds I felt a sensible relief in my breathing. Turning from the narrow drift into the main track, we progressed more rapidly, until I could see a glimmer of light at a distance. It was the candle we had left, and by the time we arrived at it I felt no difficulty at all in my breathing. I now asked the men to stay a few minutes. One held the candle, and I took the piece of sealing-wax out of my pocket, melted it at the candle—having first cut the cork off level—smeared it over with wax. We then proceeded, and soon arrived at the bottom of the shaft. Five or six miners, now full of curiosity, crowded around. One said, "That's a queer go, bringing water and taking nowt back." "Aye," said another, "and corking *nowt* down, as if it would jump out." These remarks were cut short by my conductor telling me to get into the tub, basket and all. The signal given, we mounted, and left our curiosity mongers no wiser.

The same sensations accompanied me up as on the way down, and when we emerged from the pit's mouth the sun was shining brilliantly, and the more so it appeared from being in the dark regions for some hour and a half; the daylight was to me a pleasurable surprise and delight. I experienced a similar sight in after years on emerging from the Peak Cavern in Derbyshire, after a long visit in its interior, on rounding the angle of a rock and coming suddenly to where the light came streaming in. But to my narrative; the underlooker gave an account to the banksman, who remarked that I should make a collier in time; then sent a lad with me to carry the basket and show me the way to Manchester Street, in Oldham. Having arrived there, I looked about me to see if there was any way of riding to Manchester; seeing none, I trudged along homeward. After I had gone a mile or so I saw a stand coach, with the horse's head toward Manchester, standing at a public-house door. I went in and asked the driver if he would give me a lift to Manchester. He asked me in return "If I saw any green in his eye?" After he had perpetrated his joke he told me he would take me for five shillings. I said I had no five shillings to spend, but if he would take me and the basket to 51 King Street, Manchester, I would give him half a crown. After some demur he said, "Well, get in;" and off we set, and a weary ride I got. He stopped at almost every public-house, either to drink or to let his horse drink. In two hours I landed safely in King Street. Mr. Wood was delighted and laughed heartily at my account, paid the man his two shillings and sixpence, and sent me to wash and refresh myself. When that was done I was sent to George Street with my bottles. The Doctor received me very kindly, and the quiet twinkle of his eye showed his satisfaction, which was greatly increased when he learned the particulars of my travels. He eyed the bottles with great satisfaction; he looked at the corks closely sealed, and seemed puzzled. I asked him what he was going to do with them? "Well," he said, "I am thinking how I am to get the corks out without mixing it, more or less, with the atmosphere. I want to put the air into that receiver on the shelf of that pneumatic trough." I said, "I think I could do it." He looked at me and said, "How?" I said, "File the bottle-neck round, and then a smart tap under the water I think will do it." He said, "Capital, thou shalt try." He gave me some coppers to fetch a file, and I soon filed the bottle-neck round, then held it under the shelf of the pneumetic trough; a gentle tap with the handle of a knife, and the air-bubbles very speedily rose into the receiver. The other bottles were beheaded, and very soon I took leave of the Doctor, who was apparently well pleased, and on parting said, if there was anything in his lectures which I did not understand, he wished me not to hesitate, but ask him, and he would always willingly assist me, and he was as good as his word; in fact, he showed me many little kindnesses afterward, and so ends my small reminiscence of Dr. Dalton.

MADAME KOWALEVSKI,

Professor of Mathematics at the University of Stockholm.

MADAME KOWALEVSKI.

THIS lady, a native of Russia, is a celebrated mathematician, who lectured last winter at the University of Stockholm, and who has just been appointed Professor of Mathematics at that university. We believe that this is the first time, since the middle ages (in Italy), that a woman has been appointed to an academical chair at any university in Europe. Sweden is a country where much interest has been felt in the claims of the fair sex to a full opportunity of acquiring and exercising intellectual accomplishments. The position now conceded to Madame Kowalevski is worthy of notice as a sign of the times, and will be observed with gratification by many English friends and advocates of higher education for women.—*Illustrated London News.*

ST. SIMON.

MANY owners have spent long lives and big fortunes on the turf, and have yet failed to have been the possessors at any time of a throughly good animal, while others almost at the very commencement of their career have by luck or judgment at once secured first-class thoroughbreds, and won classic races with them. The Duke of Portland, a comparatively recent accession to the racing world, is fortunate enough at the present time to possess probably the best two-year-old in Rosy Morn, and undoubtedly the best three-year-old in St. Simon, the subject of our illustration.

St. Simon is a bay colt by Galopin, the winner of the Derby in 1875, out of St. Angela, and was bred by the late Prince Batthyani, whose death caused his disqualification for the Derby this year. Those learned in pedigrees know from the parentage of St. Simon that he has in him the blood of Voltigeur, Flying Dutchman, Harkaway, Birdcatcher, Bay Middleton, Blacklock, Sir Hercules, and other celebrities; and after his racing career is over he will be among the most valuable of English sires on the ground alone that he is a son of Galopin. He made his *debut* as a racehorse at Goodwood last year, when he won the Halnaker and a Maiden Stakes. Subsequently he won the Devonshire Nursery at Derby, carrying 8 st. 12 lb., and the Prince of Wales' Nursery at Doncaster, carrying 9 st. It was also at Goodwood last year that the Duke of Richmond showed in brilliant colors, and hence the famous match made between him and St. Simon, and run over the Bretby Stakes' course at Newmarket later in the year. Though by common consent the pair were adjudged the best youngsters of the season, St. Simon was made favorite at 2 to 1 on him, and won the match easily. This year St. Simon has won a "trial match" with the evergreen Tristan at Newmarket, walked over for the Epsom Gold Cup, won the Newcastle Gold Cup, and last week the Goodwood Cup, beating the Duke of Hamilton's two representatives, Friday and Ossian, last year's Leger winner, to a stand still. Thus he has an unbeaten certificate, and considering the certainty that the Duke of Richmond, on the strength of his excellent per-

ST. SIMON, WINNER OF THE GOODWOOD CUP.

formances this year, would be a warm first favorite for the Leger, were he in it, St. Simon may claim to be far and away the best of our three-year-olds. Many good judges of horses and racing go so far as to say that he is the best animal we have had on the turf in the memory of the present generation. There are some, however, found to take exception to his conformation in certain points, and perhaps he is not so taking to the eye as have been some turf celebrities; but as, according to the proverb, a good horse may be of any color, it may not be rank heresy to add that he may be of any shape. Next year St. Simon is in the Rous Memorial and Hardwicke Stakes at Ascot, and in the famous Eclipse Stakes at Sandown.—*London Graphic.*

SCIENTIFIC BASES OF THE TEMPERANCE REFORMATION.*

By Dr. BENJAMIN WARD RICHARDSON.

ALL through the temperance ranks the arguments which appeal most strongly to the sentimental part of men's nature are being enunciated with vivid force. Nay! this enunciation is not confined to the abstinence world. Hosts of men and women of the temperate sort, who are quite as earnest, in their way, for national reformation, quite as energetic in denouncing the evils of intemperance, and quite as strong in declaring the privileges and beauties of temperance as we are, go with us, as freely as we go, up to the act of quenching the appetite for alcohol to which we, logically, proceed. I do not, therefore, consider it my duty to dwell on those parts of our argument which touch on the sentimental side. Let the good and sympathizing continue this good and sympathetic and truly evangelic work. What matters it to science if in the United Kingdom fifty thousand persons die each year from alcohol? What matters it if the judge be true who said that 90 per cent. of all the criminal cases were from the same cause? What matters it if workhouse and asylum are charged in regular course from the same cause? What matters it if every act of sedition and rebellion, if every pound of damnable dynamite, be made and laid under the influence of the agent that brings it into activity? What matter to science? Nothing. The greatest good for the greatest number in her prescription, and if this thing alcohol, bad as it may be, is necessary, let it rage and live like storms and hurricanes and earthquakes, which smite and kill, and yet out of the very womb of death bring forth the most perfect forms of life.

I shall do my part best by letting sentiment remain in other hands. For the moment I will take my stand with those who cry for the greatest good for the greatest number, be the consequences what they may. If all the evils incident to the consumption of alcohol be as bad as they are made to be; if England be doomed to wreck and ruin, to mental and physical death from it; still, if it be a part of the great natural design, if it be "absolutely necessary to man," as one of our leading publicists has recently declared it to be; if it be as necessary as fire, let it remain. Make every protection against it as against fire; insure against it; have stations to which to carry those who are injured by it; do everything that can be done to remedy all the misery it accomplishes; but, if it be "absolutely necessary," let it remain.

IS IT NECESSARY?

The scientific basis of the temperance reformation will be laid if it can be proved:

1st. That this thing alcohol is not necessary.

2d. That as a thing unnecessary it differs from many such things in being an evil thing.

I will try to prove these positions.

I need not try to prove more.

In this effort I will be careful to put forward no statement that shall overstep the views of the thoughtful men of science, whether abstainers or not, who have recently examined the questions relating to the action of alcohol upon man and life. If a point occurs on which there is reasonable doubt I will not press it, and I will give up all special personal views which I may have urged from direct experiment and observation, unless they have fallen in with general acceptance or consideration.

AGAINST THE ASSUMPTION OF ALCOHOL AS A CONSTRUCTIVE FOOD.

After a long struggle of opinion, there is now all but uniformity that alcohol supplies no structure to any part of the body.

There was never at any time the slightest scientific proof that it did; but it was assumed so to do. In my student days I was zealously taught that wines and spirits and ales made blood, that blood was liquid flesh, and that they therefore made flesh or tissue. In course of time, as the discoveries of Majendie disclosed what varieties of food really sustained the animal tissues; as the discoveries of Schwann and Schleiden disclosed the cellular formation of the tissues; and as the discoveries of Liebig unfolded the chemical relationship of various foods, it has come out, by clearest proof, that alcohol does not belong to the class of organic food substances that can build up the nitrogenous or vital parts of an animal body.

That it was not necessary for this purpose has been proved and is proved millions of times over, in the existence of the millions of millions of living things that exist without resort to the use of it. If the horse and the cow generally—to use an illustration by Dr. Munro—required alcohol for their vital sustenance, the human world employed in making this substance would be sufficiently taxed. But if all animals demanded it for the same natural reason, the whole human family, doing nothing else, would barely find time to replenish the whales, the elephants, and the hippopotami alone with the materials for their bodies, to say nothing of the requirements for the smaller kinds of animals, birds and beasts, reptiles, and other things of life. Common sense, which is the best form of common science, would point to this evidence of uselessness as all-sufficient to show that alcohol contributes, by necessity, to no structure. But, in further support, special science comes to our aid, and shows us beyond doubt that for the formation of the vital structures one particular elementary base is required, namely, nitrogen, with sulphur, phosphorus, carbon, hydrogen, and oxygen as other necessary elements, combined in a distinctive combination. She further shows us that these structure-building nitrogenous compounds are amply provided for us, ready made, in the vegetable world.

I press this argument no further. There is not an authority in the world of science who would now presume to advance the old notion that alcohol feeds the living structures, or is even indirectly necessary for their existence, or that nutrition, growth, construction, are supplied by alcohol. Every one who has to treat those unhappy members of society who come nearest to the trial of living upon alcohol knows that these are the most degenerate physical specimens extant, and the best evidences of the truth of my thesis.

There are some, perhaps, who would hold still to the exploded view, by assuming that one structure dead in its form, and dangerous as death in life, if it preponderate and replace living tissue—I mean fat—may be constructed out of alcohol in the body. There is, however, no evidence even in favor of this view. We see in our cattle-shows swine fattened until they cannot open their eyes, and cattle fattened until they can scarcely breathe, and all without a drop of alcoholic spirit as the fattener. On the other hand we learn, from experiment, that animals freely supplied with alcohol, minus all saccharine or starchy substances in connection with the supply, lose deposited fat as well as muscle. Apart, therefore, from another question which some have raised, viz., whether alcohol would be rendering a good service to man if it did promote fatty deposit in his living tissues, the balance of evidence is in favor of the view that it does no such thing, and I conclude this part by the declaration on the basis of scientific fact, that alcohol contributes nothing that is necessary for building up the animal organism of man or lower animal.

AGAINST ALCOHOL AS A SOURCE OF VITAL POWER IN THE BODY.

Under the term *vital* power, we may cover all the physical nature of the animal that is other than material. We may include the *calor vitalis*, the living fire as indicated in the living man by the heat which radiates from him; the motion that shows him to be alive; the mental acts which excite the motion; the concentrated activity; the static force ready to move in obedience to something more distinct and refined still, which our most subtile research does not yet follow, the egoic entity, the "I will."

This vital power, the associated imponderable connected with the constructive organized material and animating it, requiring, like the constructive matter, food for its manifestation, without which the body is dead—does this depend, of necessity, on alcohol for its supplies? Is an animal body made warm, strong, active, precise in activity, felicitous, by alcohol?

The answer to this question, in application to the small section of life called the human family of life, and part of it only, was an affirmative answer until quite late time. The doctrine of the schools has been, alcohol for warmth, alcohol for strength, alcohol for activity, alcohol for felicity. The poets have re-echoed the schools:

"Wine's the soul of man below."

Perchance! But where is below?

The common sense of mankind would infer, if it were thoughtful, that all provision was made naturally for the animal powers without alcohol. This fact is as patent as that relating to construction, when it is surveyed on the large scale. Animal warmth is provided for the polar bear, the seal, the northern whale, without any reference to alcohol. The esquimau keeps warm without it, and could not easily get it if he required it. Every child that is born is in want of animal warmth more in its first days than at any period of life; but it does not depend on alcohol, naturally, for its supply.

Animal strength is provided for the elephant, rhinoceros, camel, lion, eagle, and other strongest animals without any reference to alcohol. The strongest and finest built men in Europe, as Sir William Fairbairn tells us, are the boatmen or rowers to the caiques in Constantinople, men who, during their most arduous work, keep up their strength without resort to alcohol; and every one who is justly observant will find similar illustrations in his own and other communities.

Activity and precision in activity are notoriously to be obtained without the aid of alcohol. All well-trained lower animals, from finest race-horses or war-steeds down to dancing dogs, are proofs of precision in activity without resort to alcohol. Man follows in the same wake; if he wishes to shoot well, row well, walk well, fight well, write well, think well, he abstains from alcohol.

And felicity, too, the last named of the imponderable powers, is, with equal obviousness, best obtained without any reference to alcohol. The first period of life, when life is fairly surrounded by earthly comforts, is the happiest, and that is the abstaining period. The life that is least embarrassed with sadness, least troubled with emotion of sorrow, most equable in its felicity, is that life which Dr. James Johnson dignified as the life gliding most tranquilly on its course, neither exhilarated nor depressed by alcoholic aberration.

These are common matters of every-day science. They are backed by the science which is at once experimental and severe. The most acurate experimental observations demonstrate that the physical action of alcohol is to reduce the animal warmth; to bring down the effective power for physical and mental work; to render sensorial or muscular precision defective; to produce excitability of nervous action; and to keep the mind in continual change of cast and character, over-resolute, irresolute, uncertain, moving from feebleness to fury, from the brief madness of anger to the persistent madness of confirmed insanity.

How on a large scale alcohol lessens warmth of body, power of limb, precision of movement, decision of character, every shivering, trembling, uncertain, undecided victim of it whom we meet in the streets shows; every person who passes from ebriety to drunkenness shows. But Science, in her severer readings, detects that the failure of strength and precision begins much sooner and under much lighter provocation than is supposed, by the majority of mankind, to be possible. All persons admit when they see a human being passing, step by step in regular order, from his natural self into excitement, from excitement into lip palsy, from lip palsy into inarticulate palsy, and from that into limb palsy, until he colides with all that stands in the way between himself and the earth, that he has lost power, and that the gravity of the earth has brought to shame the levity of his conduct. But few conceive that the feebleness and unsteadiness were all through mere matters of degree, and that both feebleness and unsteadiness commenced so soon as the alcohol began to produce its primary effects.

My own experiments many years since gave proof of this fact, and recently, by a more refined series of experiments than mine, Dr. Ridge has shown that so small a quantity of alcohol as four fluid drachms, or half a fluid ounce, is sufficient to disturb the eye for correct vision, the muscles of the hand for detection of weight, and the sensory tip of the finger for the sense of touch. Following up this most suggestive line of research I have detected, by observations with the electric balance, that the refined sense of hearing is, in precisely the same manner, interfered with by the action of alcohol in the most primary stage of its action, and by doses considered usually of no moment.

The measurement, scientifically, of the felicity derived from alcohol shows, like all else, short commons. We men of science who follow, practically, the medical part, who, in the professional confessional, learn more of the unhappiness of human nature than all the world beside, hear of nothing so frequently, so solemnly, as the anguish produced in the happiest natures, as they were by nature, when touched by this subtle destroyer of happiness; a destroyer which makes even lower animals wild, drooping, sad, when they are taught to take it, and which ought to claim for its physiological definition, in regard to its action, dispenser of chronic sorrow.

On the scientific basis of the temperance reformation we may, without hesitation, take our stand as total abstainers, and declare ourselves, without offense, without quarrel with any one, logical in our deductions from scientific fact, whenever the question of natural necessity comes into dispute. We know in what we believe. We know we are at one with Nature in her own designings, and that in controversy with the alcoholic constitution we are not in controversy with man naturally constituted, but with man constituted on an artificial system which endows him with appetites, sentiments, reasons, that would be unknown to him if he abstained so effectively as to be free of an artificially induced aberration.

THE RESULTS OF THE UNNECESSARY.

I turn now from the question of necessity to that of resultant evils arising from the argument of necessity and the practice founded upon it.

It has always appeared to my mind, since I began to study the question upon which I am entering, that if there were necessity for alcohol, and if I, from the scientific side, should feel forced to back up the necessity, I should be driven nevertheless to admire those who would make any sacrifice rather than endure so great an evil. The mere physical injuries to our race are so overwhelming, they themselves should crush out all affection for the cause exciting them, and should lead to the discovery of something less deadly for its replacement.

When, however, it is clear that the necessity does not exist, then the mere mention of the evils is sufficient to crown the condemnation. Happily, on this subject the concurrence of scientific opinion and of expression, founded on unmistakable facts, is in no sense uncertain. There may be minor differences of opinion, but the grand results are one, and on the basis named the temperance reformation is firmly laid.

WHAT ARE THE EVILS WHICH STAND OUT BEYOND QUESTION?

The first evil is a definite calendar of disease largely peculiar to the human family, and incident to the consumption of alcohol.

Touching this calendar of disease, it is well to note the words I have just used, *peculiar to the human family.* In the lower forms of life, in our domestic animals, some of the states of disease incidental to man do not exist. Among these animals delirium tremens has no place; the peculiar disease of the liver called commonly gin drinker's liver has no place; the various forms of Bright's disease of the kidney are exceptionally present. Yet it is certain, from my own experimental observations, that all these diseases can be induced in these lower animals by training them to the use of alcohol, and that other diseases, including the *mania à potu*, may be added to the list of inducible maladies.

But the calendar of human diseases from alcohol—*morbi alcoholici*—is so large, it makes a distinctive study of itself, and now that the eyes of physicians are opened to recognize the truth, the study is expanding. When I, twenty years ago, gave the name of alcoholic phthisis to one particular class of consumption of the lungs induced by alcohol, the term was considered as an innovation, and was for a time resented. The late Dr. Francis Sibson, Senior Physician to St. Mary's Hospital in London, defended me in the use of the expression. Dr. Anstie followed, and in time the word "alcoholic," as an adjectival distinction for denoting origin of various affections, has come into wide acceptation. Thus we are now accustomed to hear not only of alcoholic phthisis, but of alcoholismus, alcoholic eclampsia or convulsion, alcoholic delirium, alcoholic epilepsy, alcoholic cirrhosis, alcoholic paralysis, alcoholic renal disease, alcoholic cardiac disease, alcoholic cerebral disease, alcoholic fatty degenerative change; and, latest, from the pens of one or two of our ablest physicians, of an alcoholic dolor or pain in the extremities, which has hitherto passed as an undefined affection.

I notice, also, as a fact very generally admitted among advanced medical scholars, that the courses of acute and chronic diseases, due primarily to other causes than alcohol, are much intensified, in respect to danger, among those who even slightly indulge in spirituous beverages. This great clinical truth is not new in medicine. It was declared with impressive emphasis by one of the shrewdest practicing surgeons who ever lived, Sir Astley Paston Cooper. It was reaffirmed by another surgeon scarcely less observant and able, the late Mr. Higginbottom, of Nottingham. I have dared in these days to follow these distinguished men in their teaching, but I have said nothing that could be more firmly said than by two who have followed me, Professor Flint, of New York, and Professor Alonzo Palmer, of the University of Michigan.

Professor Flint observes: "The toxical condition called alcoholism enters directly into the constitution of many affections such as cirrhosis of the liver, fatty liver, epilepsy, muscular tremors, gastritis, pyrosis, and various dyspeptic disorders. Indirectly, alcoholism favors the production of nearly all diseases by lessening the power of resisting their causes, while it contributes to their fatality by impairing the ability to tolerate or overcome them."

Professor Palmer, in his recent work on the "Practice of Medicine," the most truly practical volumes that have appeared on the subject since Watson's famous lectures, remarks upon alcohol:

"Absorbed it has a special attraction for the nervous tissues, for the brain, and also, though to a less extent, for the liver. It produces more or less paralysis of the vaso-motor nerves; it changes the relation of the blood and tissues, it diminishes oxidation, it causes congestion of the liver, the kidneys, the lungs, and the brain. It generally increases the sugar in the liver and the water secreted in the kidneys. It increases the tendency to the production of abnormal fat in the tissues generally, and tends to produce fatty degeneration. Above all, it acts chemically upon the soft nervous tissue.

"It causes, in its continued use, the proper nerve elements

* From the Presidential Address delivered in Section I, at the National Temperance Congress, Liverpool, Tuesday, June 17, 1884.

to waste, a serous fluid to be effused; it induces in the nervous matter the production of granular fat, and it causes development of the connective fibrous tissue. All parts of the body under its poisonous influence have a lower vitality."

Such is one of the latest deductions of science on the subject of the action of alcohol on the living organization. I am prepared to hear it said that the references made above do not refer to the moderate use of alcohol. Professor Palmer wisely forestalls this argument by adding that no one has yet been able to define the limits of moderation. That is true. What would be moderate use in one would produce some of these changes in another, and in all there would be injury.

The evidence of science is decisive as to certain local effects of alcohol on the organism, and especially on the liver, the brain, and the heart. To what extent the heart suffers, even from so-called moderate doses of alcohol, has been taught of late years with what amounts nearly to mathematical accuracy. By the sphygmograph the alcoholic heart may be made to pulse out and write out its own history. Four ounces of alcohol per day make the heart of an adult man beat 12,960 times oftener than it would otherwise do, which means the labor of raising nearly fifteen tons' weight one foot. During this labor the heart also beats more strongly so long as it is directly under the influence of the alcohol. It must do so because its own circulation is quickened. Its own vessels flushed with blood, and the tension of resistance of vessels at the extreme parts reduced, it works with a rapidity and force, derived from its own excessive blood supply, which is in excess to the degree stated, and which is wearing in proportion. To what extent the wearing takes place is best computed when the mechanism of the organ is considered.

With each stroke eleven segments of fine membranous valves are brought into sharp tension, a tension sufficient to yield an audible sound. Whether each of these finely adjusted and delicate valves—six of them not larger than a small finger-nail each, and the largest half an inch square—shall or shall not be made tense 12,960 times per day beyond what is required is a question a child might rightly answer. As a matter of fact, nature answers it surely enough in the distended, bagged, impaired condition in which the valves are found, frequently, among those who for a few years subject themselves to alcohol in doses generally considered to be free of all danger, and designated moderate.

I need not follow this section of my argument further. The production of a certain extended calendar of disease by alcohol in the human family is, so long as that family takes alcoholic drinks, inevitable. On that basic fact alone we have a sufficient scientific reason for the reformation we demand. If bread by its use produced the same unvarying phenomena of disease, we should be scientifically justified in demanding that even bread itself should be discontinued and replaced by some less deleterious food.

One reason leads to another. A certain measure of matured disease affecting vital organs, whatever the cause at work may be, is sure to lead to a certain reduction in the value of life and to a certain excess of mortality.

That such a result is shown through alcoholic disease is so positive that the knowledge of it is being acted upon with the greatest severity of commercial balance and exactitude. There is no occasion now to go to books of refined scientific character to grasp this truth; unpoetical actuarial day-books and ledgers, directors' reports, and shareholders' votes record it.

It was not my intention to refer to any of these commercial results when I sat down to compose this address, because I did not suppose I could say anything new. But while the address was in hand I have received a copy of the *Insurance Guardian*, an able paper, which is in no sense specially wedded to our cause, though it is open to honest conviction; and there I find an article bearing on the returns, just published, of the "Scepter Life Association." This company has two sections, a general and a temperance section. It has 5,730 in the general, 3,270 in the temperance. In its last annual computation it turned out that the deaths in the general section were 68, or rather less than 12 per 1,000 living at risk; and in the temperance section 12, or less than 4 per 1,000 living at risk. But lest it might be supposed that this was an exceptional return, as indeed it was, the deaths from the beginning, twenty years ago, have been compared, and have shown 12 per 1,000 at risk in the general, 7·8 per 1,000 at risk in the temperance division. In the past five years the expected claims in the temperance section were 153. The claims actually demanded were 53, or about one-third of the number expected.

No more scientific argument could be found in defense of abstinence as compared with moderate drinking. If a late advocate for four ounces of alcohol a day could manipulate, after his fashion, the 3,270 members at risk on the temperance side of the Scepter Life Association, it would be rather an unpleasant position in a year or two to be the actuary or board of that now excellent institution. I feel morally sure that in its general section the members are not subjected to so dangerous a toxic practice as the consumption of four ounces of alcohol daily.

That part of the scientific basis of the temperance reformation which is made up of facts relating to the better value of life and activity of the abstaining community, is of all others the most obviously sound. Our opponents may trample on it as they like, sneer at it as they like, fire at it their heaviest missiles. They will not move it.

DISEASE AS LIGHTENED BY ABSTINENCE.

I could follow up the history just rendered by a reference to other histories bearing on sanity and insanity, suicide and heredity. Suffice it to say that the lesson would be the same.

There is one more topic on which, for the sake of faithfulness of testimony, I must dwell before I lay down the pen. I have been now thirty-four years in active medical practice. Except during brief vacations, I have never been out of harness, and I do not think I have been more profoundly asleep to what is going on in the special world in which I live than the rest of my contemporaries. And this is the conclusion I have been led to, until it is an unshaken conclusion—that among those who practice total abstinence, not only is mortality much reduced, but, when recoverable sickness falls to them, the severity of it and the period of it are also remarkably reduced. In the acute stages of disease, the acuteness is, as a rule, less severe; in the convalescent stages, the recovery is more rapid. These rules hold good in respect to the epidemic diseases, in respect to wounds and injuries, and in respect even to some diseases which are more immediately of hereditary type, as insanity, gout, rheumatism. I am further perfectly sure that these results, although up to the present time drawn from a limited and fortunate part of the community, are affecting in the most signal way the material interests of the professors of medical art, to the extent even of lessening their numerical strength as an organized portion of the working community.

In the ten years ending 1881, the numbers constituting the body of religious teachers increased 14·7, which was as nearly as possible the increase of the population. The practicing members of the legal profession, barristers and solicitors, increased 12 per cent. The professors of education, schoolmasters and schoolmistresses, increased 34 per cent. Musicians, 38 per cent.; actors and actresses, 30; dentists, 45. But of medical men actually practicing medicine or surgery, or both, the increase was less than 3 per cent.

Dr. William Farr, who occasionally enjoyed a fling at us abstainers, once told me his belief, in real earnest, that if all men became abstainers, the number of medical men required for public service would remain stationary, while the population continued in its regular progress. How fast that prediction is being fulfilled, these latest census returns better indicate than any further words of mine. They are most significant, and although we temperance folk must not take the credit all to ourselves, seeing that other great outlets of sanitary progress are adding their assistance to health, we may accept fairly that, in the opinion of the most eminent English statistician of the century, our health and life saving labors enter largely into the calculation.

Finally, such facts run well with the figures which Dr. Ridge and the late Rev. Eardley Stanton, and other investigators, have collected in relation to the fewer days of sickness of the abstainers in provident clubs, as compared with the days of sickness of those who do not abstain; while they indicate, even from the present small scale on which they are represented, what an enormous change in the sickness of the nation would occur if all the members of these grand societies were of the same mind in practical support of our cause.

There is one order alone, the unparalleled order of Odd Fellows, which, accepting temperance lines as its lines, could in a single year produce an appreciable reduction in the national cost for disease and in the national mortality.

I implore the more thoughtful of our people who have not yet looked at temperance in the light here presented, to tarry a moment to look at this one of its bases, which I venture to declare is laid. I pray them to examine the basis for themselves, to demolish it, if it be unsound, ruthlessly, completely. I pray them, equally, if it withstand their molestation, as I believe it will, to join in erecting upon it a part of that edifice of temperance which, resting on a hundred other and equally sound foundations, will one day be the glory of an emancipated, chastened, purified, and beautified human world.

THE GERM ORIGIN OF DISEASE.

AN abstract from an article by Dr. W. S. Newton, in the Peoria *Medical Monthly:*

When a disease has a germ origin, it presents to us in its course some of the traits or phenomena of organic life, animal or floral.

Let us name a few of those phenomena, and then apply them to our common diseases:

1st. Animals and plants are so nearly similar that what fact will apply to one applies to the other also. An egg of an animal and a seed of a plant are similar structures and the beginning of all organic life. After life is originated, in many cases it may be propagated by buds. To start life from seeds and eggs, they must be submitted to either germination or incubation and consequent fermentation.

2d. Germination or incubation puts in motion a force called fermentation or zymosis. No organic body can decay and rot without fermentation Flesh, fruit, and all organic bodies would never decay if millions of germs did not incubate in every fiber and atom, and set up fermentation and consequent decay.

The tooth of oxygen may eat iron and nearly all metals without germ life; but when organic bodies decay, incubation or germination starts the process. In some countries meat is elevated in the air above germ life, and this saves it from putrefaction even when the days are hot. Fruit is sealed in cans, not to keep out air, but germ life. *In any disease then where there is putrefaction and fermentation or zymosis, there is abundant germ life for a cause.*

3d. There are floral and zoological zones around the earth, running with the equator or parallels, and each zone has its peculiar flora and fauna. If the elephant and other phenomenal animals and plants live in such zones, microscopic animals and plants causing disease will do so also.

4th. Some plants and animals flourish in certain regions—in swamps, in valleys dark and cold—and some are marine or aquatic, and some inhabit sandy plains. When germs of this kind cause disease, we call the malady endemic.

5th. Animals can travel with the wind and against it. Plants are carried by streams and the wind and by animals, and never against the wind.

6th. Plants grow in the warm days of summer, rest in winter, and with the spring revive again. Insects also live in the summer.

7th. Animals may be entozoal and live in the dark, true parasites, but plants cannot flourish in the dark. Wood and Gray both say plants must have light for healthy growth. When plants cause disease, we must suppose they grow on the surface of the body in the light. Animal germs may live anywhere in the body, in the dark and in the light.

8th. Animals and plants are not attacked by parasites when in perfect health, like when they are sickly and weak.

9th. Certain agents destroy organic life when applied to it. We call these agents antiseptics.

Let us now try some of our common diseases by these traits or forms of organic life, and see whether we can find any similarity.

Typhus and Typhoid Fevers have plantings and growings. Zymotic, zoological zone for former. Antiseptics influence them.

Small-Pox, Scarlatina, Measles, and other eruptions—Planting and hatching, travel against the wind, zymotic zones for some of them. Antiseptic influence.

Whooping Cough and Mumps—Planted and incubation, travel against the wind. Spread by germs.

Ague and Intermittent Fever—Planted and germinate. Travel from swamps with wind, flourish in the summer, rest in the winter, start up to life in the spring. Antiseptics influence.

Goitre—Endemic to mountain valleys; affects the weak; is influenced by antiseptics.

Consumption and Scrofula—Seem to grow after planting; afflict the weak; have a zone; affected by antiseptics; grow in the dark; seem to be animal germs causing them.

Cancer and Lupus—Incubated and grow to maturity; may be planted; seems to spread by budding like protozoans.

Gonorrhœa and Syphilis—Planted, seem to incubate, and at maturity bear seeds or eggs; affected by antiseptics.

Leprosy and Skin Diseases—Grow in the light; afflict the weak; spread to planting.

Hydrophobia, Snake Bite, and Skunk Bite—Grow by planting; seem to be affected by antiseptics; zymotic.

Rheumatism—Flourishes in damp weather; influenced by antiseptics. Said to be zymotic.

Yellow Fever—Has a zone; flourishes in warm weather like the plants and hexapods.

Erysipelas, Influenza, Puerperal Fever, Typhoid Pneumonia, and Putrid Sore Throat—Spread by planting; affected by antiseptics; zymotic.

LEPROSY, AND ITS DANGERS.

GOOD results may follow evil methods, and whether Dr. O'Donnell be a charlatan and an alarmist or not, he has excited interest in a subject that deserves the attention of the American people.

Leprosy is not a disease of which those who are cleanly and chaste need ever have any fear; but as a large number of American citizens possess neither of these virtues, it is well that they provide against the contingency of elephantiasis græcorum. For there is little doubt that leprosy is contagious just as syphilis is contagious, *i. e.*, through the agency of the secretions and blood. Among licentious people it may spread with rapidity. The influence of heredity is also potent in increasing the number of victims. Lepers reproduce lepers, though fortunately the second generation dies before it can be productive.

The contagion of leprosy, according to Dr. George Thin, lies unquestionably in the *bacillus lepræ*, first discovered by Hansen. This bacillus resembles very closely that of tuberculosis. Its habitat is the lymph or white blood-corpuscle, which it changes into the leprous cell. It makes of this an irritative body, producing the peculiar exudations and low grade inflammatory conditions characteristic of the disease.

The parasitic theory of leprosy is an interesting one, and, if true, would throw a new light upon methods of prophylaxis and treatment. It is difficult, however, to explain satisfactorily by this theory the facts of hereditary transmission of the disease, and especially such a one as is given by Dr. A. W. Saxe. That writer says: The healthy wife of a leper gave birth to a leprous child. Her husband died. The still healthy widow married a healthy man, and gave birth again to a leprous child.

As regards China and leprosy, it is to be borne in mind that, if we are to legislate against the disease, we must not single out China. Leprosy exists also in Mexico, the West Indies, India, Norway, Sweden, New Brunswick, Australia, the Sandwich Islands, Eastern Africa—in fact, on the seacoast in nearly all tropical regions.

In India there are said to be over 100,000 lepers; the number in China is unknown, but is unquestionably great. The Hawaiians, of all people, are most scourged by it, nearly one-tenth of the population being affected.

Four years ago there were between fifty and one hundred lepers in the United States. Whether this number has increased we cannot say. One thing is certain, however, that the disease cannot be spread by the simple exhibition of cases of leprosy before the public. However bad the taste or useless and sensational the object of such a performance, it would be as innocent to public health as the exhibition of a like number of cases of syphilis.

The citizens of New York who have been so worried over the possible introduction of leprosy into this city, should be informed that for years there have been one or more lepers in the city hospitals, one even having served for a time as a nurse in Bellevue Hospital.

While leprosy is a disease about which much is unknown, there are certain facts that are tolerably well established. These have been formulated by Dr. A. W. Saxe ("Report on Hawaiian Leprosy") as follows:

"1. Leprosy is not a form of syphilis.

"2. It is a specific and well-marked disease.

"3. There are two varieties—the *tubercular* and *anæsthetic* [some add a third, the *macular*].

"4. These varieties may be distinct or associated.

"5. It is more common in males than females.

"6. It is hereditary.

"7. It is contagious.

"8. It is incurable.

"9. Europeans are to a certain extent exempt from the disease, probably from greater precautions in avoiding the contagion.

"10. The causes of the disease are unkown.

"Finally, leprosy disappears with improved hygienic conditions of a people, cultivation of the soil, and absolute isolation of all lepers.

In some cases, we would add, the disease seems to disappear despite the most favorable conditions for its propagation, as has been noted in the Virgin Islands by Dr. Bonn. —*Medical Record.*

HOG INSPECTION A NECESSITY.

IN 1881 I examined twenty hogs and found trichinæ in two, one of them exceedingly full; in 1882 I examined twenty-five, and found but one that contained any of the parasites. Last year I examined at various times during the year fifteen, and found one that contained trichinæ; these were hogs that had been killed and were sold on our market. I also, during the past winter, examined the muscles of three hogs that had died and were left on the street a few days, and found trichinæ in each of them in great abundance; they were fed in very dirty pens and where rats greatly abounded.

These parasites have been found in the flesh of man, the hog, the cats, rats, mice, the hippopotamus, and other animals. Two or three years ago, while examining a piece of one of the pectoral muscles of a frog, which had been caught in the branch that carries away the water of our pork house, I discovered it full of trichinæ. I believe this is the first instance where the parasite has been discovered in the frog. The hippopotamus had been fed offal at the zoological gardens of New York, and doubtless contracted the parasite in that manner.

Two years ago a cat, living at my barn, had five kittens. When the kittens were about eight weeks old the mother sickened and died; about the same time the kittens also became sick, and one after another died. I examined pieces of the muscles of the mother and each of the kittens, as they died, and in all I find vast multitudes of encysted and encysting trichinæ, and great numbers of free trichinæ in the stomach and intestines. A short time before the mother-cat sickened, I found her and her kittens making a meal off a large rat which she had killed, and which was probably the source of infection.

Recently I received a small piece of human muscle, from

Dr. C. H. Stowell, of the Michigan State University, and editor of the *Microscope*, at Ann Arbor, which is very full of parasites. I have a specimen of it here, mounted, ready for examination under the microscope, which contains thirteen encysted trichinæ. If the person from whom this muscle was taken was a medium sized person, and all parts of the voluntary muscles were as full as this, he or she must have furnished a home for at least sixty to eighty millions of the parasites.

From all the information derived from my own experience and examinations, and those of others, I am of the opinion that the number of our hogs infected will vary from two to eight per cent. on an average; that in badly kept piggeries and lots, in the presence of rats and other vermin, the per cent. is largely increased; but where hogs are kept in large, clean places away from buildings and rats, and where they are not permitted to eat those that die, trichinæ will seldom be found.—*T. B. Redding.*

GLEANINGS FROM THE ROYAL MICROSCOPICAL JOURNAL ON BACTERIA.

C. H. STOWELL.

Micrococci of Pneumonia.—The greater number of these micrococci are surrounded by a more or less broad layer resembling an envelope or capsule, colored light blue or red by gentian-violet or fuchsin respectively, and usually sharply defined externally. Sometimes two or three micrococci are inclosed in the same envelope; but they are never collected together into zooglœa colonies. These envelopes are soluble in water and dilute alkalies, but insoluble in acids. The envelopes are colored by eosin, especially by weak solutions acting for twenty-four hours. These envelopes appear to be *a highly characteristic peculiarity of the micrococci of pneumonia.* They probably belong to the acme of that disease, not being found after the sixth day.

Bacteria of the Cattle Distemper.—The bacterium of this disease has been supposed to exist only in the bacillus condition. Lately, however, it has been found in the early stage of the disease in the blood and in the lymphatics and spleen, in the form of small, round, shining bodies or micrococci.

Thus the micrococci and bacilli represent *stages of development of the same organism.*

Bacteria in the Milk of Animals infected with Charbon.—The question has been raised whether the milk of a female in lactation affected with charbon contains the microbium of the infection. Recent experiments show conclusively that *bacteria are found in the milk of animals* infected with charbon while they are still alive; but in much less numbers than in the blood.

Micro-organisms in Soils.—The superficial layers of the soil are rich in germs of bacteria, particularly in bacilli. Micrococci were only found in places which had not been cleansed from decaying matter. The quantity of micro-organisms diminished very rapidly with increase of depth, and below one meter the soil is comparatively free from them. In one gramme of soil taken 0·20 meter from the surface, it was estimated there were in each of three samples: 700,000, 870,000, and 900,000 organisms. These organisms may have an important function *in the transformation of substances to forms suitable to plant-food.*

Bacteria on the Surface of Coins.—Bacteria and algæ have been found in great abundance in the incrustations and sediments on silver and copper coins, especially old coins that have been in constant use for twenty or thirty years.

Some of the sediment is placed in a drop of water, and examined at once. Starch grains and various minute bodies are found.

Two unicellular organisms are so constant that they are considered not as accidentally adherent substances, but as *organisms which have their continual origin and seat in the incrustations of coins in currency.* The two new species are: *Chroococcus monetarum* and *Protococcus monetarum.*

Action of Cold on Microbes.—Various organisms, such as bacilli, when subjected to a temperature of 70° C. for 108 hours, and to 130° for 20 hours, are not destroyed; others, such as torula and the vaccine microbe, lost their power of producing fermentation.—*The Microscope.*

SPONGE.

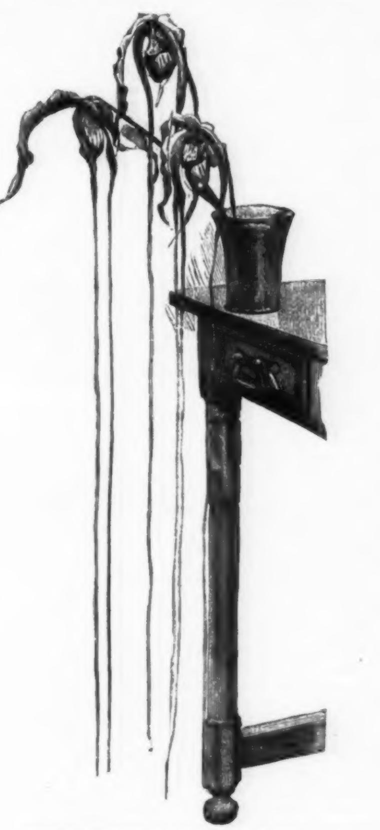
THE material known in commerce as sponge is obtained by divers from the sea bottom in the neighborhood of the Greek Archipelago, the Bahamas, and other parts of the world, but it is not the whole animal, but only a supporting skeleton from which all the living matter has been removed by washing, squeezing, and bleaching in the sun. If a piece of this sponge be examined with the naked eye, there will be seen numerous large more or less circular openings leading to canals which branch and penetrate the sponge in all parts and freely communicate with one another. A simple lens of high power will show that the substance of this skeleton is composed of an open feltwork of curling and branching fibers of a horny substance called *keratode* (Gr. *keras*, horn; *eidos*, form). In a living sponge this cannot be made out, for the skeleton is then covered with a slimy material, and only the larger openings are then visible. Sections of the living sponge in any direction would show that this same slimy substance pervaded the whole interior, covering all the fibers and lamellæ and leaving only a series of narrow, branched canals, the smaller branches of which communicated with a number of microscopic openings called "pores" in the outside of this gelatinous mass.

If a healthy sponge be examined in some of its native water, to which some finely divided solid substance—say carmine—has been added, it may be observed that currents of water are constantly flowing into these pores, while other currents are streaming away from the larger apertures, called *oscula* (Lat. dim. of *os*, mouth). It is thus evident that there is a constant circulation of water entering the sponge by the smaller pores or *inhalent* apertures, traversing the various channels in the substance of the sponge, and emerging from the larger oscula or *exhalent* apertures.

Sections of fresh sponge display the fact that the slimy substance—the so-called *sponge flesh*—consists of an assemblage of nucleated corpuscles or *sarcoids*, about $\frac{1}{2000}$ or $\frac{1}{3000}$ of an inch in diameter, and of irregular and inconstant form. Each consists of a speck of colorless protoplasm, the semi-fluid granular interior of which—the *endosarc*—passes into a firmer clear outer layer—the *ectosarc*. In the endosarc, besides the nucleus there is sometimes a little cavity—*contractile vesicle*—endowed with the power of rhythmic dilatation and contraction. The sarcoid has the power of changing its form by the protrusion of blunt processes from any part of its body, and when free from the mass it can crawl about by the same means. It bears, in fact, a remarkably close resemblance to an amœba. In various parts of the canals, especially near the surface of the sponge, there are found round or oval chambers, lined with a layer of sarcoids, which present some advance in structure on the amœbiform type. Their form is usually columnar or oval, they possess nuclei and contractile vesicles, and their outer layer frequently assumes the character of a distinct limiting membrane. Each possesses a long *flagellum* (Lat. for whip), which it is capable of lashing backward. In many forms the limiting membrane is raised up round the base of the flagellum into a membranous collar, and the sarcoid very closely resembles certain collared infusoria. Occasionally very peculiar forms are met with, where the flagellum and collar are borne at the end of a long neck. We can now understand that the currents which traverse the sponge are caused by the co-ordinated lashing in one direction of the flagella in these *ciliated chambers*, as they are called. But how is this co-ordination brought about? We do not know. It is one of the mysteries of protozoic life. Generally on the outside of the sponge, and less constantly in various parts of the interior, masses of nucleated protoplasm occur, which present a variation from the amœbal type in the opposite direction to that taken by the flagellated sarcoids, which we have seen is one of elaboration and specialization. The masses in question present a degradation of structure, for the sarcoids of which they originally consisted have lost all their individuality, and fused into a continuous film or *syncytium*, as Haeckel calls it, and all that remains to mark their presence is their nuclei, but the mass still retains its functional activity.—*Cole's Studies.*

CYPRIPEDIUM CAUDATUM.

THE annexed engraving of C. caudatum represents a reduced sketch of an extraordinarily fine spike of the long-tailed Lady's Slipper orchid, which we received a week or two ago from Messrs. Thomson, Tweedside Vineyard, Clovenfords, who grow all kinds of orchids uncommonly well. The tail-like sepals of the flowers here represented were of unusual length, being 33½ inches from the center of the flower to the tip of the tail. The spike had a singular appearance, and moreover represented the highest colored variety, named roseum.—*The Garden.*



CYPRIPEDIUM CAUDATUM.

TALL-GROWING CAMPANULAS.

BELLWORTS have always held a deservedly high place among hardy plants, and for variety of form and fine shades of color, especially blues, it would be hard to find their equals in any other genus. As regards size, they vary from the most diminutive of flowering plants, such as C. Raineri, C. cenisia, etc., of the high Alps, to the Siberian C. lactiflora and the Canterbury Bells of Southern Europe. The dwarfness of the former two eminently fits them for the embellishment of shelves or ledges in the rockery and other places where it is desirable to have green natural carpets, beautiful in their season; and the latter two, along with a few more of the taller growing sorts, stand unrivaled for the decoration of beds and mixed flower borders; even in their native countries they are said to constitute most striking ornaments in the landscape, as they tower above dwarfer plants, or, as seen peeping through the taller growing bushes, reminding one of the Foxgloves of our woods and groves. When naturalized and associated with Foxgloves, Ragged Robin, and others of our tall-growing wild plants, the effect of the contrast is most pleasing; indeed, in this way only can we make our woods and shady walks interesting or beautiful.

C. Lactiflora is an extremely pretty Caucasian species, bold and showy in appearance. It grows from 3 feet to 4 feet high. It has a pyramidal branching habit, and bears a profusion of blue tinted flowers, which last more or less all through the summer. They are cup-shaped, somewhat drooping, and have the segments slightly turned back; the leaves, which are narrow, clasp the stem, and are finely serrated. To grow it to perfection it requires a rich, heavy loam, and is all the better for having a shady position. C. lactiflora cœrulea is a lovely variety, with bright blue flowers and much the same habit as the type. Both are very useful border plants, and often used for beds in the flower garden in company with Lobelia cardinalis. They are increased by means of seed or division of the roots.

C. Bononiensis (Panicled Harebell) is a neat habited species, which grows from 3 feet to 4 feet high, and bears many small ascending branchlets, on which are borne pretty bell-shaped flowers, varying in color from violet to pure white. The leaves are small, oval, or almost cordate, rough to the touch, and having a white nap underneath. It is a native of Bologna, Austria, etc., and a very useful plant for borders or rockery.

The Peach-Leaved Harebell (C. persicifolia) is a native of Europe from Sweden to Spain, and is said also to be found naturalized in some parts of this country. It was cultivated by Gerard as early as 1596. It grows from 2 feet to 3 feet in height, and when planted in large clumps presents a very handsome appearance. The leaves are very sparingly distributed on the stem, which is unbranched, and they are very narrow and long; the flowers are blue and broadly campanulate. There are five or six varieties of this species, among the best of which are alba, a kind with double flowers, and coronata, the latter being the more beautiful of the two, and well deserving a place in every collection. They commence

THE CREEPING BELLFLOWER (CAMPANULA RAPUNCULOIDES).

flowering in June, and when the summer is not too dry last till September.

Broad-Leaved Harebell (C. latifolia), which Sir Walter Scott calls the "throatwort with its azure bell," is one of the handsomest and most useful of the genus for naturalizing in woods, etc., as it has a preference for shady places, in which it will reach from 4 feet to 5 feet in height if the soil be rich. The stems are stout, often branching, and densely covered with broad, oval, doubly serrated leaves. The flowers, which are purplish, have long tubes, and are produced at the axils of the leaves, generally one, but often two or three if the plants are strong. The lowermost flowers open first.

C. Latifolia Macrantha has a much a dwarfer habit than that of the above, and it may also be distinguished by the flowers being of a deeper purple and having longer tubes. This and the variety Van Houttei are very useful for the rockery; requiring a cool situation and heavy loam. They flower from June to August.

C. Pyramidalis, although a much more fashionable plant thirty or forty years ago, when it was cultivated principally for decorating halls, staircases, etc., than now, it still holds a high place among hardy flowering plants. Along with Canterbury Bells it has become almost indispensable for the decoration of the greenhouse and conservatory in autumn. It is also very useful for forming light screens in the flower garden, for which purpose, however, the plants are best grown in pots and planted out in spring. It is a perennial, but never so strong as in the first year; it is therefore advisable to divide the old plants and grow a stock from the offsets or raise seedlings; the latter are the most satisfactory, being always the strongest. The seed should be sown in autumn as soon as it is ripe, in pots under glass; prick off the seedlings when up, and give them a shift as soon as they are ready to handle. The protection of a cold frame will be found quite sufficient for them. In rich top-dressed ground this Campanula often reaches a height of from 6 feet to 7 feet, the stem being straight, much branched, and pyramidal, and well furnished with flowers from the bottom to top. The leaves are smooth, shiny, and evenly serrated, those at the root cordate, the upper ones being much narrower and ovate; flowers

spreading, five parted, light blue, sometimes white. It is a native of Southern Europe, and flowers late in the summer and autumn.

C. Latiloba (C. grandis).—This plant is closely allied to persicifolia, from which, however, it differs in having sessile flowers and large permanent bracts. It is very useful for the decoration of rock work, the more so as it forms dense masses of persistent lanceolate leaves, slightly undulated. It grows from 3 feet to 4 feet high, with a closely set spike of flat purple flowers. There is also a white variety.

The Creeping Bellflower (C. rapunculoides), the subject of the accompanying illustration, is one of the boldest and showiest of our native flowers. In some parts of Scotland—Fife, for instance—it is very common, but less so in England, and it is naturalized in America. It is well worth growing in the hardy plant border, as it is so handsome when in flowers. When well developed it is a yard or more in height, and the slender stems are burdened with drooping, purple bells, as shown in the picture. It needs no culture, and will hold its own against the strongest.—*D. K. The Garden.*

THE RED AFTER-GLOW.

A correspondent of *Nature*, F. A. R. R., who assumes as correct the generally assumed theory of volcanic dust as the cause of the red after-glow in the skies, explains the subject as follows:

The matter projected into the upper atmosphere appears to have passed round the globe westward with great velocity, and to have diffused itself toward north and south much less rapidly. A stratum of fine dust thus formed itself at an elevation probably exceeding the altitude of the known upper currents. This stratum caused the sun to look green or blue on the Gold Coast, in the West Indies, at the Sandwich Islands, in India and the Indian Ocean, and last, as late as September 24, in the Soudan, nearly a month after the eruption of Krakatoa. The moon and stars were frequently greenish in Europe in December and January, up to four months and a half after the eruption, and the sun whiter than usual toward setting. The finely divided matter which thus deprived the sun and moon of part the rays which go to form the compound white, was plainly of a different grain from the small particles commonly present in the sky, for these arrest the blue rays and scatter them, allowing the rays toward the red end of the spectrum a freer passage, so as to impress the eye with the predominant red color of luminous objects seen through a long stretch of atmosphere.

Since the declining sun in India turned strongly green, the particles competent to arrest the red rays must have exceeded, in the path of the rays, the ordinary blue-arresting particles in quantity or power. But as the sun approached close to the horizon, the lower atmosphere, by cutting off the more refrangible rays, reduced the green, and sometimes caused the red to predominate in the setting sun. The particles of a common blue haze cause the sun to set deep red. The volcanic dust particles may have exceeded in magnitude the particles which cause haze, and possibly the stratum may have contained particles which might be visible under the microscope. That this dust stratum was still present in the higher atmosphere in January was indicated by the greenish tinge of moon and stars. It was largely composed of particles of sufficient magnitude to reflect white light, for a little before sunrise the sky seemed clouded over with something resembling white cirrus haze; but like a film of dust on a mirror, or the floating dust in a room, it was not visible except at certain angles. Condensed vapor, or ice particles in a very fine state of division, would account for the persistent halo or corona of varying radius, but so also would particles of transparent pumice.

Assuming the red-arresting stratum to have remained during the autumn and winter months at altitudes from forty to twenty miles, descending say 1,000 feet per day during 100 days, the effects observed after sunset and before sunrise were only what might be expected to follow by reflection from the minute surfaces. In the case of ordinary cirrus, the tints up to half an hour after sunset are as follows: white, pale yellow, yellow, orange, pink, red, deep red; or the red only may be visible if the texture be thin and the early twilight strong. With a continuous red-arresting stratum, however, we must consider what influence its horizontal breadth, through which the sun's rays must pass when near setting, would have upon the light reflected from the western sky. At a height of thirty miles the sun would be shining through a great length of the stratum, as viewed from the elevated point, when it had already set on the earth immediately below.

At this point, thirty miles above the earth's surface, supposing that to be the height of the stratum, the vapor of the lower air would not yet be strongly exerting its influence in arresting the blue rays, but the sheet of dust would exert its maximum power of stopping the red rays, and the light which survived best, and which from the earth's surface we should see reflected soon after sunset from above the western horizon, would be green. The stratum being so composed as to be capable of reflecting all kinds of light, but by its own action through a great breadth filtering out some of the less refrangible rays, as it did more powerfully in India when less attenuated, the reflected light of the sun above the western horizon, and indeed toward north and south as well, could not fail to be affected with an excess of green. As the sun sank still lower, viewed from the height of thirty miles, it would begin to be largely robbed of the blue and green rays by the ordinary lower atmosphere, and the next color in the western sky would consequently be yellow, which would equally be reflected by the matter composing the stratum.

The yellow would be the result of a competition between the red-arresting upper dust and the blue-arresting lower air. As the sun descended still lower, the power of the ordinary vapor charged strata would assert itself, and the yellow would pass to orange, pink, and crimson, just as the color of the sun seen from any eminence commonly changes in setting. The under haze would merely reflect these naturally changing colors, but the later tints would be more striking as darkness increased. All the changes observed in the first after-glow are thus fully accounted for by larger than ordinary sky particles arresting red waves and the general mass of the stratum reflecting all rays falling upon it. The secondary after-glow would show similar gradations if the first were strong enough to emit much light, but the red in it would be most conspicuous, for the action of the lower air in eliminating blue would be more powerful than the thin veil of dust in eliminating red. There was, however, a distinct greening of the eastern sky on several occasions, signifying the approach of the secondary after-glow. The increase of apparent brilliancy of both glows as they sank westward would of course be due to perspective.

MAKING CHEESE FOR HOME USE.

To the Editor of the Scientific American Supplement:

In the Supplement of last week you have an article on making cheese for home use, purporting to be a copy of a prize essay by a person in Prince Edward's Island. I regret to be compelled to say that this article was written by me for another paper, to which I contribute occasionally, and was published on Feb. 27, 1884. The lady who got the prize for this essay, copied word for word from my article, has therefore obtained the money by false pretenses. I have written the *Farmer's Advocate*, London, Canada, explaining these facts.

It is no unusual thing for such articles of mine to get into various papers for which they were not written, and I never take notice of such things; but when a person uses my work to compete for a money prize, the point where a line should be drawn is reached.

Yours respectfully,
H. Stewart,
Agricultural Ed., Weekly N. Y. Times.

Hackensack, N. J., August 28, 1884.

SEA SHELLS AND THEIR INHABITANTS.

Wonderful and beautiful as the shells look, they are, after all, only the used-up homes of the still more astonishing things that lived within them and grew out of them. What marvel of nature is there that excels, for instance, the nautilus shell and yet how much more interesting is the cuttle-fish creature that made it, adding room after room, and walling up the old one it had left! It lived three hundred fathoms under the sea upon little crabs and lobsters, and was itself one day murdered by an old one, its beautiful house burglariously entered, and its body dragged out. Lying on the ocean bed, comfortably attached to a piece of coral, it probably spread out its arms, as the anemones about it were doing, and waited there, in the green twilight, for the little crustaceans that went frisking about inquisitively among the deep-sea vegetation, and incautiously frolicked themselves into the grasp of the expectant tentacles. Or, tired of repose in one spot, what a curious sight it must be to see these shelled things pumping the water through their siphons, and jerking themselves at each squirt backward! Although the naturalist has found out many of their secrets, the whole story of the nautilus' life has never been told, since living specimens have been very few and far between. The shells are common enough, for when the crabs or lobsters have eaten the tenants, their residences, no longer anchored, float up to the surface, and the tide washes them on to rock and beach. Associated with them in fiction and fancy, though separated from them by many species in nature, is the huge tridacna, the shell in which, the Greeks tell us, Venus, the foam-born, was found floating, and known to collectors as "the gigantic clam." It holds a sea-snail that weighs often twenty pounds, itself weighing five hundredweight; and has hinges of such strength that without battering it to pieces the man who once got his hand gripped within it would have no chance of extricating himself. The tritons, too, a superb family of shell-fish, are familiar in old world myth as the trumpets which the courtiers who surrounded King Neptune in his voyages used to blow to let the sea folk know that his Majesty was coming, and to summon the mermen and the mermaids to pay their homage to the monarch of the waves. They are still used, these large conches, as the war horns of savage tribes; and weird and wild are the sounds that come wailing over the water as the battle canoes shoot out from the bank in pursuit of enemy or victim.

The fountain shell, again, with its rosy lining, what a beautiful object it is, and how it conjures up to the mind the possible loveliness of those sandy plains and valleys, down, deep down, at the bottom of the sea, where these and other ocean jewels lie scattered doubtless in endless multitude. As the material upon which most cameos are cut, this fountain shell is, in its fragments, familiar enough in Europe, while in other countries the savages delight in it, cutting bracelets out of it and grinding pieces down into beads, or shaping others into arrow and harpoon heads. Then there are the lovely cone shells, the graceful spires, the exquisite elegant "olives," with their artistic blending of tints, the Janthenia, with its violet hues, and the apple shells that have as strange tenacity of life as the "rose of Jericho;" the whipping top shells with their wondrous front door lids, the chiton that rolls itself up like an armadillo and looks as indigestible as possible when anything threatens to eat it; the sea hare that stains the water purple to hide itself from pursuers, and the univalves that take their popular names from the objects they seem to resemble—"bubble," and "umbrella," and "watering-pot." Then again, the cowries, admired all the world over for their bold coloring as the handsomest of shells, spotted or blotched, and barred like leopards and tiger cats; and the pecten and scallop family painted as beautifully as any flowers, and as brilliant when laid out in numbers together as a parterre of pansies. Or for pure beauty what is there to excel some of the cockles, or the mussels, the surpassing isocardia, or the lantern shells? For daintiness of marking and intricate ingenuity of design, the wings of butterflies and moths will hardly compare with some of these works of the sea snails, while for fragile delicacy what can excel the paper nautilus? Then there exist some thin fairy bubble textures that on the water seem to be only water and light themselves, and taken up in the hand fill the mind with astonishment that fabrics so frail would ever have borne the washing of the waves or sufficed for the home of a living animal. Yet they are not all so innocently fragile, so helpless in their loveliness. The mugilus, for instance, started like its relatives the "augers" in being a respectable snail living properly in a curly shell, but by and by it developed an appetite for coral insects, and set to work to bore through the block, always taking care, the fastidious wretch, to keep so near the surface that it was sure of its tiny victims being "all alive." The pholas, too, that manages with a tongue of velvet to drill through solid rock, and the dactylus, apparently as unfitted for such a life as can be imagined, that perforates stone, and the teredo navalis, which makes lace of woodwork and reduces a plank to the appearance of a piece of wasp's nest.

Many others, again, are remarkable, apart from their beauty, for their products; for instance, the colossal byssus, that throws out trusses of silk so fine and strong in fiber that it can be worked up into articles of clothing, and the mussels, which, if left undisturbed, will weave crumbling masonry together by filling all the crevices with the curious bunches of sea thread. Above all, however, ought probably to be ranked those shell fish that give man food, and, though these are legion, they are but few, the periwinkle and cockle, scallop, whelk, mussel, and oyster, that are obtainable in any quantity to make the consumption of commercial importance, and of all these the oyster deserves the prominence it has obtained. Nature has given it but a poor shell to look at. It is very wonderful, no doubt, the life of the oyster, as interpreted for us by such expert decipherers of natural secrets as a Sowerby or a Woodward, or as pleasantly translated by a Buckland or a Gosse; but when all its labors are ended, and the mature bivalve lies awaiting its destiny, the shell in which the dainty morsel is ensconced is not much to look at. It has, therefore, been somehow the fashion to poke fun at the oyster. Yet no one should forget how splendidly it triumphs even in such a contest of rival beauties as the shell world offers, when the rough ribbed rind is forced open and that wonder of the sea is disclosed to view, the pearl. By itself it suffices to fill the ocean with an exquisite mystery, and through all ages has delighted the fancy of man. Such, most imperfectly suggested, is the world of marvels, of dainty color, and of fascinating elegance in which the conchologist carries on his studies.—*London Telegraph.*

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